ASTM Bulletin

NEWS—Fiftieth Anniversary Meeting Details; ASTM Standards in New Jersey Turnpike; New Committees on Cellulose and Mass Spectrometry; New Publications.

PAPERS—Rapid Estimation of Cement Content; Test Methods for Paintbrushes; Determination of Residual Stresses; Heat Distortion of Polystyrene; Tension Testing of Rubber and Related Elastomers; Abrasion Resistance Tester.

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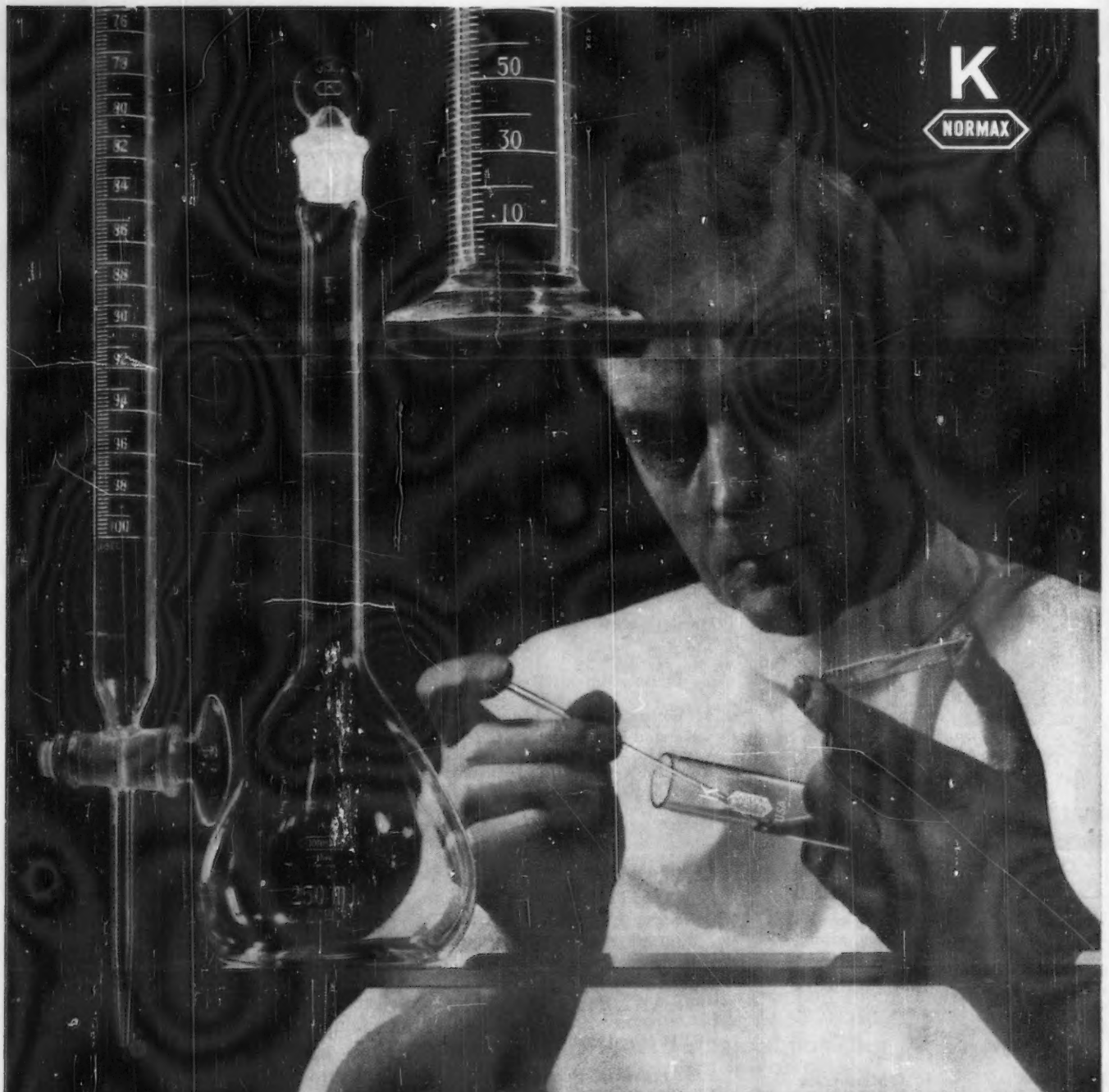

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"Promotion of Knowledge of Materials of Engineering, and Standardization of Specifications and Methods of Testing"

TELEPHONE—Rittenhouse 6-5315 R. E. Hess, Editor R. J. Painter, Associate Editor CABLE ADDRESS—TESTING, Philadelphia

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1902 — *1952*

Advance Notes on Fiftieth Anniversary Meeting

1952 Meeting in New York Includes Extensive Technical Program, Apparatus and Photographic Exhibits, Entertainment Program, Laboratory Visits, Committee Meetings—June 23-27

MANY of the activities which will comprise the Fiftieth Anniversary Meeting of the Society are rapidly rounding into final shape. Work on some of these features including the technical program has been under way for many months, and the various functions for which the New York Committee on Arrangements is responsible, such as entertainment, laboratory visits, photographic exhibit, and finances, have long since moved from the planning stage into active work.

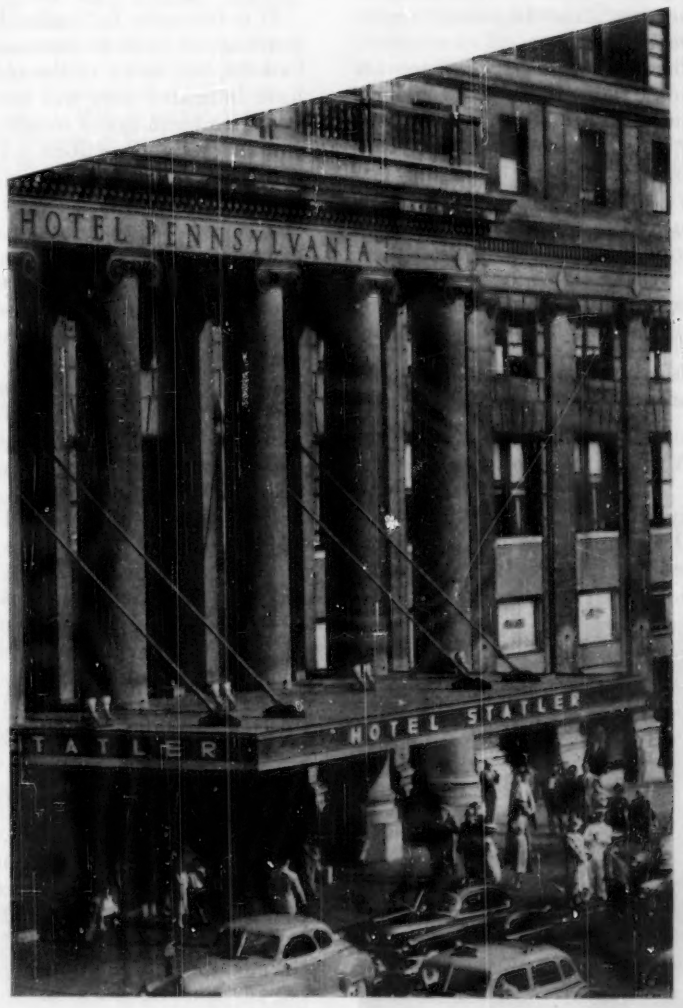
The meeting will extend from Sunday, June 22, to Friday, June 27, inclusive, and the events will be concentrated at the Hotels Statler and New Yorker.

Dr. Bronk to Address Meeting:

One development which will be of widespread interest is the acceptance of Dr. Detlev W. Bronk, President of Johns Hopkins University, and President of the National Academy of Sciences, as the feature speaker at the Anniversary Dinner scheduled for Wednesday, June 25. A leader for many years in research and technical activities, Dr. Bronk will have a message that is both thought-provoking and interesting.

Luncheon Session:

The annual address of the President, T. S. Fuller, messages of greeting from two representatives of national and foreign bodies, together with the presentation of awards, will feature the luncheon session, Tuesday, June 24.



Technical Sessions:

Although there will be a tremendous amount of activity at the meeting, the features are being arranged so that those concerned with particular in-

Hotel Reservation for Anniversary Meeting

The managements of the Hotels Statler and New Yorker, which are the main cooperating hotels and at which the major functions will be held, have reserved large blocks of rooms for our members and their families throughout the week of the meeting. Although it is anticipated some of our members have various preferences, those who will wish to stay at the headquarters hotels are advised they will receive the customary hotel reservation form. This will give full information on how to make reservations and cover the room facilities available. While it is estimated the two main hotels have sufficient capacity to take care of virtually all requirements, arrangements have been made for other room facilities in this area.

dustries and problems may be permitted to participate in as many of the respective functions as possible. A good example is the technical program which includes some 28 sessions required for formal symposiums, groups of papers and lectures, plus another eight or ten sessions required to provide ample time for the presentation of numerous other technical papers and reports.

On the following pages there are given some details of the technical symposiums to be held at the meeting. Further data will appear in the April and May BULLETINS. These issues will give an outline of the over-all program and note the days on which the various features are scheduled. At this writing it can be noted many of the sessions relating to metals will be held in the forepart of the week.

Edgar Marburg and Gillett Memorial Lectures:

As announced previously the 1952 Edgar Marburg Lecture is to be given by Dr. R. C. McMaster, Battelle Memorial Institute, on the subject "Non-Destructive Testing." This is scheduled for Wednesday afternoon, June 25.

The first H. W. Gillett Memorial Lecture by Normal L. Mochel, Westinghouse Electric Corp., is to be on Monday afternoon, June 23, the intriguing subject selected by the Lecturer being "Man, Metals, and Power."

Committee Meetings:

It is too early to predict how many meetings of technical committees will be held, but many of the main groups have indicated they will hold sessions and with them many meetings of subcommittees and sections. It is anticipated some of the committees will take advantage of the previous week end to get together, and particularly to have many of their subcommittees meet so that there may be a bit more time for the committee members to participate in other features, particularly some of the technical sessions. Meeting facilities will be available beginning Saturday, June 21, and the Technical Staff will cooperate with the committees in developing a schedule.

Further information will be given in subsequent BULLETINS and by mail on times of committee meetings, *but the official call to such meetings and official times will be issued by the secretaries of the respective committees.* Except in the final program, available as each man registers, there is no previously published complete committee schedule.

Exhibit of Testing Apparatus and Laboratory Supplies:

The accompanying article refers to the Tenth Apparatus Exhibit and also to the Eighth Photographic Exhibit, both of which will be in progress throughout the meeting. The apparatus exhibit will be in the Statler's Ballroom and Ballroom Foyer conveniently located adjacent to the registration desk so that members and the large number of visitors expected will be able to inspect the displays from time to time. This exhibit provides a unique and convenient opportunity to get at first hand latest information on instruments, supplies, and related equipment used in testing, research, production control, and related fields.

Laboratory Visits:

Under the direction of Dr. Lincoln T. Work, Consulting Engineer, a committee is perfecting plans for members to visit some the of leading laboratories in the New York area. All members in the New York District received a request from Dr. Work's committee to advise of special facilities that they would like to see, and also to offer to make available their laboratories for visits. The committee was cognizant that our members might be interested particularly in special equipment and unusual processes and is operating on this premise.

Whether any group visits are planned will depend upon the reaction of the members when they receive further details which will appear in the April BULLETIN. In summary, the New York Committee on Laboratory Visits will post our members on what laboratories in New York are cooperating, give an idea of any unusual facilities that could be inspected, and will give the name of a contact man at the laboratory so that the member can make his own appointments. If any group visits develop, full information will be furnished.

Ladies' Activities—Social Functions:

Under the direction of Mr. Sam Tour, Chairman of Board, Sam Tour and Co., Inc., a program of entertainment and plans for organized functions for the ladies are being completed. While some details are already decided, further descriptions of entertainment features will be covered in the April and May BULLETINS, and separate mailings. *However, members are urged to acquaint their wives and families with the fact that the New York Committee headed by Mr. Tour will provide a number of very interesting functions, and the ladies can be assured of a pleasant and delighful time while at the meeting.*

Such things as tickets to radio and TV broadcasts are in mind; a special tea, cocktail party preceding the dinner, and dancing and entertainment following this feature are among the "fare" already on the menu.

New York is replete with interesting places to go and things to do and the committee will have information on these.

1952 Annual Meeting Symposiums

THE December 1951 issue of the BULLETIN listed titles and authors of some of the papers in the symposiums scheduled for the 1952 Annual Meeting. Given below is a list of all symposiums that will be presented. These listings are subject to changes and additions.

The Provisional Program for the 1952 Annual Meeting will be published in the May BULLETIN listing all the papers with a summary of each.

Symposium on Light Microscopy

(Sponsored by Committee E-1 on Methods of Testing)

A General Talk on Methods of Microscopy—C. W. Mason, Cornell University

Apparatus for Microscopy—H. W. Zieler, W. H. Kessel & Co.

Some Applications of Light Microscopy to the Study of Textile Materials—V. W. Tripp, Southern Regional Research Laboratory, United States Department of Agriculture

Light Microscopy as Applied to Resins and Plastics—T. G. Rochow, American Cyanamid Co.

The Microscopic Examination of Metallic Specimens—J. R. Vilella, United States Steel Co.

Particle Size—R. P. Loveland, Eastman Kodak Co.

There may be several additional papers included in this symposium.

Symposium on Plastics Testing—Present and Future

(Sponsored by Committee D-20 on Plastics)

Introduction—G. M. Kline, National Bureau of Standards

Measurement and Significance of Mechanical Strength Properties of Plastics—C. H. Adams, Monsanto Chemical Co.

Effect of Temperature on Some Physical Properties of Plastics—E B. Cooper, E. I. du Pont de Nemours & Co., Inc.

Measurement of Color Haze and Gloss—H. K. Hammond, III, National Bureau of Standards and G. W. Ingle, Monsanto Chemical Co.

Effect of Molding Conditions on Permanence of Plastics—J. W. Mighton and J. L. Williams, The Dow Chemical Co.

There will be several additional papers included in this symposium.

Symposium on Tin

(Sponsored by Committee B-2 on Non-Ferrous Metals and Alloys)

Tin Resources and Production—Stewart Miller, Pacific Tin Consolidated Co.

Electrotinning—F. A. Lowenheim, Metal and Thermit Corp.

Effect of Impurities on Performance of Tin—Frederick J. Dunkerley, Univ. of Pennsylvania.

The Determination of Small Amounts of Impurities in Tin—Marie Farnsworth, Metal and Thermit Corp.

Round Table Discussion on Analytical Procedures for Tin—Jointly with Committees E-3 on Chemical Analysis of Metals and E-2 on Emission Spectroscopy

Symposium on Factors Affecting the Durability of Concrete

(Sponsored by Committee C-9 on Concrete and Concrete Aggregates)

Significant Factors Affecting Concrete Durability—C. H. Scholer, Kansas State College

Experimental Exposure of Concrete to Natural Weathering in Marine Locations—H. K. Cook, Corps of Engineers, Waterways Experiment Station

Performance of Concrete Specimens During 10 Years Exposure to Severe Natural Weathering—W. J. McCoy, Lehigh Portland Cement Co.

Correlation of Sodium Sulfate Soundness of Coarse Aggregate with Durability and Compressive Strength of Air-Entrained Concrete—C. A. Vollick and E. I. Skillman, U. S. Bureau of Reclamation

Studies of a Severe Abnormal Expansion of Portland Cement Concrete Containing a Siliceous Sand and Gravel Aggregate of a Nature Common in the Central Great Plains Region of the United States—A. D. Conrow, Ash Grove Lime and Portland Cement Co.

Symposium on Effects of Notches and Metallurgical Changes on Strength and Ductility of Metals at Elevated Temperatures

(Sponsored by Joint Committee on Effect of Temperature on the Properties of Metals)

Effect of Notch Geometry on Rupture Strength at Elevated Temperatures—E. A. Davis and M. J. Manjoine, Westinghouse Electric Corp.

Creep to Rupture of N-155 Alloy in Torsion and Tension—C. W. MacGregor and F. J. Walcott, Massachusetts Institute of Technology

An Experimental Study of the Strength and Ductility of Steel at Elevated Temperatures—John Glen, Colvilles Ltd., Scotland

Behavior of Stainless Steels at Elevated Temperatures—A. B. Wilder and E. F. Ketterer, National Tube Co.

The Influence of Sharp Notches on the Stress Rupture Characteristics of Several Heat Resistant Alloys—W. F. Brown, Jr. and M. H. Jones, Lewis Laboratory, NACA

Recovery and Creep in an Alloy Steel—H. A. Lequear and J. D. Lubahn, General Electric Co.

A Survey of Embrittlement and Notch Sensitivity in Creep Loading of Heat Resisting Steels, W. F. Brown, Jr., NACA

Effect of Sigma on Strength and Ductility of 25 Cr-20 Ni Steel—G. V. Smith and E. J. Dulis, United States Steel Co.

Effect of a Notch and of Titanium Content on the Rupture Strength of Discaloy—F. C. Hull, E. K. Hann, and H. Scott, Westinghouse Electric Corp.

Ductility at Static Strength Maxima in Plain and Notched Test Specimens—H. Scott, Westinghouse Electric Corp.

Investigations Into the Effect of Notches on the Results of Long-Time Rupture Tests at Elevated Temperatures—W. Seigfried, Sulzer Bros., Ltd.

Rupture Test Elongation and Its Significance—Donald N. Frey, Ford Motor Co.

The Effect of Grain Size and Test Temperature on the Fatigue Properties of a Precision Cast Co-Cr-Ni-W Alloys—P. R. Toolin, Westinghouse Electric Corp.

Fatigue Strength of "Refractaloy-26" as Affected by Temperature, Hardness, and Grain Size—P. R. Toolin and F. C. Hull, Westinghouse Electric Corp.

Symposium on Exchange Phenomena in Soils

(Sponsored by Committee D-18 on Soils for Engineering Purposes)
—Ralph E. Grim

Cation Exchange Capacity in Loess and Its Relation to Engineering Properties—Donald T. Davidson, Iowa State College

Job Experience with Exchange Phenomena Involving Inorganic and Organic Ions—Hans F. Winterkorn, Princeton University

Surface-Chemical Properties of Clay Minerals and Soils as Revealed by Recent Experimental and Theoretical Developments in Electro-Osmosis—Gerhard Schmid, Technische Hochschule Stuttgart, and Hans F. Winterkorn, Princeton University

Electrically Induced Exchange—E. F. Preece, Corps of Engineers

Symposium on Direct Shear Testing of Soils

(Sponsored by Committee D-18 on Soils for Engineering Purposes)

Controlled Volume Direct Shear Test—Donald Taylor, Massachusetts Institute of Technology

The Strength of Gravel in Direct Shear—R. G. Hennes, University of Washington

The Use of Direct Shear Tests in Earth Work Projects Under Construction—R. R. Proctor, Los Angeles Department of Water and Power

The Use of Direct Shear Tests in Engineering Practice—F. J. Converse, University of California

Use of Direct Shear Tests in Highway Design—E. S. Barber and C. L. Sawyer, Bureau of Public Roads

The Place of Direct Shear Testing in Soil Mechanics—D. M. Burmister, Columbia University

Symposium on Test Methods for Process Control in Ceramic Whitewares

(*Sponsored by Committee C-21 on Ceramic Whitewares*)

The Status and the Importance of Terminology in Ceramic Whitewares—Arthur S. Watts, Ohio State University

Possibilities for Adapting Research Tools for Process Control Evaluations—John H. Koenig, Rutgers University

Report on Round-Robin Investigation of Modulus of Rupture Tests—Rolland Roup, Globe-Union, Inc.

Report on Round-Robin Investigation on Methods of Evaluating Subsieve Particle Sizes of Non-Plastic Materials—C. J. Koenig, Ohio State University

Evaluation of the Critical Properties of Clays—T. A. Klinefelter U. S. Bureau of Mines

Report on Committee Investigation of Process Control in the Whitewares Industry—C. H. Commons, Locke Dept., General Electric Co.

Symposium on Continuous Water Analysis

(*Sponsored by Committee D-19 on Industrial Water*)

Continuous Sampling of Industrial Water—M. F. Madarasz, Ford Motor Co.

Some Practical Aspects of the Measurement of pH, Electrical Conductivity and Oxidation-Reduction Potential of Industrial Water—Robert Rosenthal, Industrial Instruments, Inc.

Discussion on Continuous Analysis of Industrial Waste Water—A. E. Griffin, Wallace & Tiernan Co., Inc.

Measurement of Color, Turbidity, Hardness and Silica in Industrial Waters—F. C. Staats, Hercules Powder Co.

The Continuous Measurement of Dissolved Gases in Water—J. K. Rummel, S. T. Powell

Symposium on Determination of Elastic Constants

(*Sponsored by Committee E-1 on Methods of Testing*)

Report on ASTM Task Group for Determination of Elastic Constants—Walter Ramberg, National Bureau of Standards

Influence of Temperature on the Elastic Moduli and Poisson's Ratio of Various Commercial Steels—G. V. Smith, F. Garofalo, and P. R. Malenock, United States Steel Co.

Dynamic Methods for Determining Elastic Constants and Their Temperature Variation in Metals—M. E. Fine, Bell Telephone Laboratories, Inc.

An Evaluation of Several Static and Dynamic Methods for Determining Elastic Moduli—J. T. Richards, The Beryllium Corp.

Methods for Determining the Elastic Constants of Nonmetallic Materials—E. W. Kuenzi, U. S. Forest Products Laboratory

Symposium on Conditions and Weathering

(*Sponsored by Committee E-1 on Methods of Testing*)

General Introduction

Fundamentals of Atmospheric Elements—Benarthur C. Haynes, United States Weather Bureau

Textiles—Robert H. Brown, Parks-Cramer Co.

Conditioning and Weathering of Paper—William R. Willets, Titanium Pigment Corp.

Adhesives and Organic Plastics—Frank Reinhart, National Bureau of Standards, and Lucius Gilman, Picatinny Arsenal

Organic Coatings—Edward J. Dunn, Jr., National Lead Co.

Metallic Coatings—Clarence H. Sample, International Nickel Co.

Large Scale Conditioning—A. E. Stacey, Jr., Carrier Corp.

Small Scale Conditioning—Kenneth N. Mathes, General Electric Co.

Outdoor Exposure Testing on Racks and Fences—Kenneth G. Compton, Bell Telephone Laboratories

Accelerated Weathering Devices—Roscoe H. Sawyer, Devoe & Reynolds Co.

Symposium on Testing Adhesives for Durability and Permanence

(*Sponsored by Committee D-14 on Adhesives*)

Measurement of Deterioration of Adhesive Bonds by a Nondestructive Ultrasonic Method—A. G. H. Dietz, H. N. Bockstruck, George Epstein, Massachusetts Institute of Technology

Metal-to-Metal Adhesives—W. C. Larson and T. J. Martin, Wright Development Center

Current Investigations of the Durability of Woodworking Adhesives—R. F. Blomquist, Forest Products Laboratory

There will be several additional papers included in this symposium.

Symposium on Fretting Corrosion

(*Sponsored by D-2 on Petroleum Products and Lubricants*)

Introductory Remarks for Symposium on Fretting Corrosion and Description of NACA Research on Fretting—Douglas Godfrey, National Advisory Committee on Aeronautics

The Present Status of the Problem of Fretting Wear—W. E. Campbell, Bell Telephone Laboratories

Effect of Lubricants in Minimizing Fretting Corrosion—E. W. Herbek and R. F. Strohecker, The Texas Co.

There will also be a film and a paper on "Fretting Corrosion in Industry" and a summary type paper.

In addition to the above there will be several sessions on fatigue, and a session on paint.

Members Invited to Exhibit Photographs and Photomicrographs During 50th Anniversary Meeting

THE Committee on the Photographic Exhibit at the 50th Anniversary Meeting at its organization meeting in February acted to extend an invitation to all members and committee members of the Society and any professional or amateur photographers affiliated with company members to participate in the Society's 1952 Photographic Exhibit during the week of June 23 in New York City. The theme of the Exhibit will be similar to earlier ones, namely, "Materials, Testing, and Research."

In March all members will receive by direct mail a combined prospectus-entry form covering the exhibit but meanwhile those interested may wish to be thinking of what they would enter.

These Photographic Exhibits have been features of meetings in the even numbered years and a large number of extremely interesting prints and photomicrographs have been shown.

The New York Committee, which includes in its personnel a number of authorities in this field, together with official representation from Committee E-4 on Metallography, which again is sponsoring the section on photomicrography, anticipates a continuation of the increasing interest in those phases of photography covered in the scope.

Student Participation

Committee E-4, through the Chairman of Subcommittee IV on Photography, Sidney W. Poole, Republic Steel Corp., has written to the deans of engineering of leading schools advising of the interest of Committee E-4 in having student participation in work on metallography. The committee is anxious to encourage continuing betterment in practices and techniques used in this important field. A number of student prizes will be awarded.

Start planning now to participate in this Exhibit.

1952 Exhibit of Testing Apparatus and Laboratory Supplies

CONTINUING indications are that the ASTM Exhibit of Testing Apparatus and Laboratory Supplies will be one of our most successful to date. Fifty-five of the available booths, have already been applied for. Specific booth assignments will be given shortly —as soon as an adequate study of overall requirements has been made. The booth applications in the hands of the Society indicate that many new and interesting pieces of apparatus will be exhibited. The exhibit should provide members and guests with an excellent opportunity to see at first hand the latest developments in this increasingly significant field. Aside from the perennial favorite, Atlantic City, home of 37 Annual Meetings, New York is next in line with 5 meetings. A fairly frequent location for these Meetings, the city was selected in 1900, 1912, 1937, 1944 and 1945.

As a center of population and industrial development, New York should be a particularly fine spot for the 50th ANNIVERSARY MEETING—particularly since the meeting will have a distinctly international flavor.

Revision of Cement Specifications

ON JANUARY 16, 1952, the Administrative Committee on Standards approved tentative revision of Standard Specifications for Portland Cement (C 150–49), and revision of Tentative Specifications for Air-Entraining Portland Cement (C 175–51 T), making provision in each for air-permeability fineness limits, and for the use of the recently revised time of setting test (C 191–51 T) as an alternate test. Revision of the two specifications appears in the 1951 Supplement to Book of ASTM Standards, Part 3.

J. R. Townsend Appointed Consultant to ODM Director Wilson

MANY members will be keenly interested in learning of the appointment of Past-President John R. Townsend to Charles E. Wilson's ODM Staff in Washington. As Consultant on Conservation of Materials, Mr. Townsend will advise on utilization and conservation, and will have an important part in the Government's program involving conservation through substitution.

In his capacity as Director of the Office of Defense Mobilization, Mr. Wilson, through a member of his staff, Dr. Oliver Buckley, requested the assistance of ASTM in the whole program of conservation. The appointment of Past-President Townsend, who recently has been made Director of Materials Applications Engineering of his company, Bell Telephone Laboratories, Inc., is a first step in this project. Announcements of other developments are expected to be made shortly.

"Now READ 'em."

Courtesy *Iron Age*

Pending Actions on Standards for Steel, Electrical Heating Alloys, Road Materials, Electrical Insulating Materials, Plastics, Adhesives, Soils

ON FEBRUARY 15 the Administrative Committee on Standards will meet at Headquarters to review many recommended revisions in standards and proposed new tentatives as submitted by several technical committees. There are many items from Committees A-1, B-4, D-4, D-9 (also D-9 and D-20 jointly), D-14 and D-18. A complete list of the actions will appear in the April ASTM BULLETIN and this news account will convey some idea of the major changes. Copies of the specifications will then be made available in separate pamphlet form and some will go into special compilations that are to be rushed, including the Steel Piping Compilation.

Errata in Pipe Specifications A 158 and A 335

A TYPOGRAPHICAL error has been pointed out in the Tentative Specifications for Seamless Alloy-Steel Pipe for High-Temperature Service (A 158 – 51 T) reprinted in separate form and also appearing on p. 54 of the 1951 Supplement to Book of ASTM Standards, Part 1. In grades P3a and P3b of Table I, the phosphorus, sulfur, silicon, and nickel contents should read as follows:

	Grade P3a		Grade P3b	
	Ladle Analysis	Check Analysis	Ladle Analysis	Check Analysis
Phosphorus, max, per cent	0.025	0.030	0.025	0.030
Sulfur, max, per cent	0.025	0.030	0.025	0.030
Silicon, per cent	0.45 to 0.75	0.40 to 0.80	0.45 max	0.50 max
Nickel, per cent	.....	.....	.....	.....

For grades P11 and P15 the nickel, chromium, and molybdenum contents should read as follows:

	Grade P11		Grade P15	
	Ladle Analysis	Check Analysis	Ladle Analysis	Check Analysis
Nickle, per cent	.....	.....	.....	.....
Chromium, per cent	1.05 to 1.45	1.00 to 1.50	.....	.....
Molybdenum, per cent	0.48 to 0.63	0.45 to 0.66	0.48 to 0.63	0.45 to .

Also in the Tentative Specifications for Seamless Ferritic Alloy Steel Pipe for High Temperature Service (A 335 – 51 T), reprinted and on p. 231 of the 1951 Part 1 Supplement, the chemical requirements for grades P21 and P22 should be broken down into ladle and check analysis requirements to read as follows:

	Grade P21		Grade P22	
	Ladle Analysis	Check Analysis	Ladle Analysis	Check Analysis
Carbon, per cent	0.14 max	0.15 max	0.14 max	0.15 max
Manganese, per cent	0.33 to 0.57	0.30 to 0.60	0.33 to 0.57	0.30 to 0.60
Phosphorus, max, per cent	0.025	0.030	0.025	0.030
Sulfur, max, per cent	0.025	0.030	0.025	0.030
Silicon, per cent	0.45 max	0.50 max	0.45 max	0.50 max
Chromium, per cent	2.75 to 3.25	2.65 to 3.35	2.00 to 2.50	1.90 to 2.60
Molybdenum, per cent	0.83 to 1.03	0.80 to 1.06	0.90 to 1.10	0.87 to 1.13

1951 Supplements Completed—1952 Book of Standards in Planning Stage

With the completion and mailing of the 1951 Supplement to Part 3 of the Book of Standards, all six 1951 Supplements have been completed. Totalling 1948 pages, these Supplements bring up to date the 1949 Book and the 1950 Supplements. Yellow stickers were included in each of the Parts so that the older books could be earmarked where revisions and changes were made in 1951.

A set of Emergency Alternate Provisions (pink slips) which were applicable to certain of the standards was distributed with the respective 1951 Supplements. (A list of these EA's appeared on page 15 of the December Bulletin.)

Each member should check his files and make sure that he has a Supplement to the parts of the Book of Standards he uses. If there are any questions, a note to Headquarters will bring further information.

Copies on Sale:

In addition to the distribution of these Supplements to members on their membership, many others, particularly companies, purchase copies of the Supplements and while full information has been furnished to all those who have *purchased* 1949 Books of Standards and the 1950 Supplement, it might be noted that extra copies of each Part of the 1951 Supplement are available to members at $2.75 each or $16.50 for the complete set of six. The list price to nonmembers for this complete set is $21.

1952 Book of Standards

The complete new Book of Standards for 1952, which will again be the triennial publication year for the big Book, is to be issued in seven parts instead of six parts effective with the 1949 edition. Full details were given on page 15 of the January Bulletin.

Because Part 5 of the Book, covering textiles, soaps, fuels, petroleum, etc., would be too large it was decided to limit the contents of Part 5 to fuels, petroleum, and aromatic hydrocarbons, and to shift to the new Part 7, all standards covering textiles, water, and soaps.

With the statements covering the 1952 membership dues, each member received information in a letter signed by the President, regarding the readjusted nominal annual charges to members for copies of Parts of the 1952 Book.

It is expected that the seven parts in 1952 will total more than 10,000 pages about 20 per cent greater than the 1949 edition.

It is hoped the first of the 1952 Parts to be ready can start coming off the press in December.

The Elevated-Temperature Properties of Stainless Steels

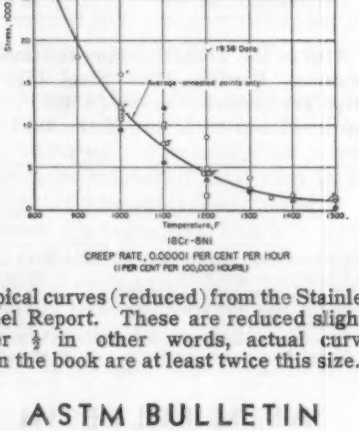
This extensive 130-page report, sponsored by the Joint (ASTM-ASME) Committee on the Effect of Temperature on the Properties of Materials (Data and Publications Panel), and prepared by Ward F. Simmons and Howard C. Cross, Battelle Memorial Institute, is essentially a graphical summary of elevated-temperature data for the commercially produced stainless steels. Included are summary curves for tensile strength, 0.2 per cent offset yield strength, per cent elongation, per cent reduction of area, stresses for rupture in 100, 1000, 10,000, and 100,000 hr and stress for creep rates 0.0001 and 0.00001 per cent per hr (1 per cent in 10,000 and 100,000 hr).

An Appendix is included, which contains the primary data from which the summary curves were drawn. The data sheets in the Appendix also give the chemical composition, processing data, and other pertinent information about the steels included in this survey.

In the presentation of the data, it was desirable to indicate in a general way the processing each material had received. Therefore, the figures were drawn, using various symbols for annealed, cold-drawn, cast, etc. These classifications are very broad and are intended to serve only as a guide for those who are not interested in the details of processing.

This collection of data of widespread interest resulted from the close cooperation of leading organizations concerned with the production of stainless alloys, their fabrication into valves, flanges, fittings, piping, etc., and the users.

The publication will meet the need for data on the part of those establishing stress values and code requirements, designers of equipment of all kinds, particularly where elevated temperatures are involved, metallurgists who must supervise the production of the steels or the construction and the products therefrom, and technical people generally who are concerned with operating problems.


Data Sheet Numbers Corresponding to Points Below
Stress, 1000 psi
1938 Data
Average annealed points only
Temperature, F
18Cr-8Ni
CREEP RATE, 0.00001 PER CENT PER HOUR
(1 PER CENT PER 100,000 HOURS)

Typical curves (reduced) from the Stainless Steel Report. These are reduced slightly over ½ in other words, actual curves in the book are at least twice this size.

Only through joint cooperation of many companies and individuals could a publication of this kind be issued and it is in services of this kind that the Joint Committee has established an enviable record of accomplishment. Reference might be made also to the personal interest of Mr. Simmons in supervising so closely the preparation of the charts and tables and collation of data.

This 130-page publication (STP No. 124), 8½ by 11 in., heavy paper cover, sells for $4; to ASTM and ASME members, $3.

Erratum

We regret that the Foreword of the recently published *Triaxial Testing of Soils and Bituminous Mixtures* erroneously credits the sponsorship of the original symposiums to Committee D-4 rather than to Committee D-18 on Soils for Engineering Purposes. The latter committee under the chairmanship of E. J. Kilcawley originated the idea of a triaxial symposium and its separate publication, and accordingly sponsored the Tenth and Eleventh Sessions of the 1950 Annual Meeting at which many of the papers included in this special technical publication were presented. The subcommittee directly responsible for this special work was headed by W. G. Holtz, Secretary of D-18.

Bibliography of Photoelectric Spectrophotometric Methods of Analysis for Inorganic Ions

CONTINUED requests for a revised edition of the bibliography on photoelectric spectrophotometric methods which appeared in the 1944 ASTM *Proceedings* has resulted in a greatly expanded new edition soon to be available as Special Technical Publication No. 125.

The bibliography has been prepared by J. W. Stillman, Chairman of Committee E-3 on Chemical Analysis of Metals, and author of the 1944 edition; and E. C. Dunlop.

Spectrophotometry has become an important tool to the analytical chemist. The information on spectrophotometric methods which have been developed for the determination of various metallic ions is scattered through the literature, and in order to make this information more readily available, the authors have selected references from two leading analytical journals and arranged them according to the metal to be determined. It is hoped that this will provide the analytical chemist with the information he needs without the necessity of a tedious search through the literature.

This bibliography covers the Analytical Edition of *Industrial and Engineering Chemistry*, Vol. 1 through *Analytical Chemistry*, Vol. 23, No. 10 (1951) and *The Analyst*, Vol. 62 through Vol. 76, No. 906 (1951). The references from *Industrial and Engineering Chemistry*, Vol. 1 to 16, No. 6, and *The Analyst*, Vol. 62 to Vol. 69, No. 5, represent the portion previously published in the ASTM *Proceedings*, Vol. 44, p. 740 (1944).

The 24-page paperbound book is listed at $1.50; $1.15 to members.

Membership Curve Keeps Climbing

New Companies, Institutions, and Individuals Participate in Work

AN ANALYSIS of membership at the end of 1951 showed almost 7100 individuals, companies, institutions, and various branches of government in this country and abroad were participating in the benefits extended to members of the Society. The accompanying curves, in a sense, give the story, but it might be noted that 1951 was a good year from the standpoint of growth. It was the third best year for new members, the total 672 being exceeded only by 1946 and 1947, with their figures of 686 and 680, respectively. After deducting losses, which were much lower in 1951 than for any year since 1946, there was a net gain of 276, again only exceeded by a few years in the period 1942–1946—the World War II years.

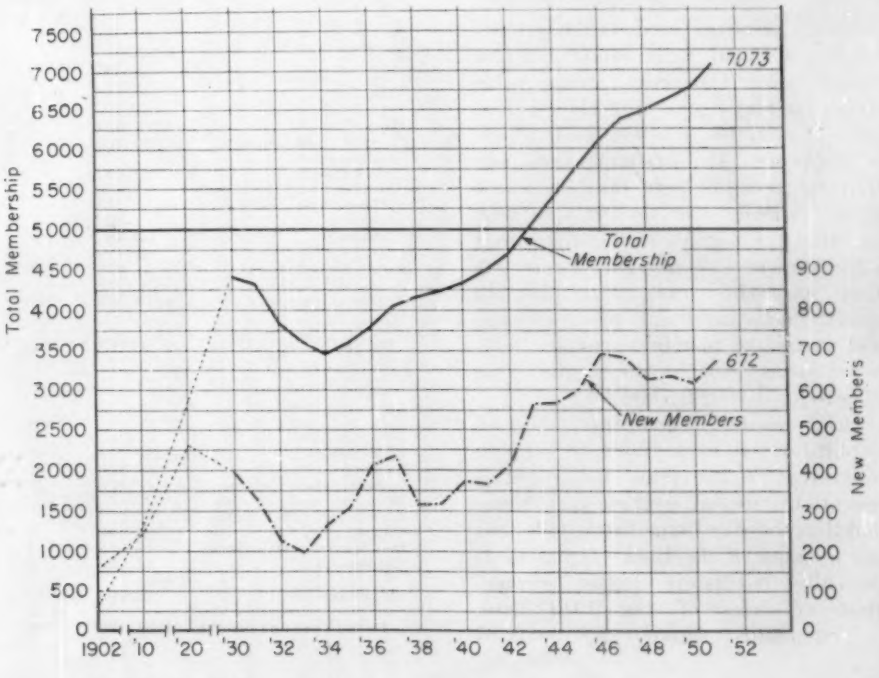
In its January report to the Board of Directors, the ASTM Membership Committee, headed by C. H. Fellows, indicated gratification with the statistics, and noted that 1952 started off in good shape with a large number of new companies and individuals joining. (See page 26 of this BULLETIN for a list.)

Among the interesting points brought out in review of membership for 1951 was the fact that some 40 companies transferred from their company class to the sustaining class, which increased the number of sustaining members to about 250. At the same time, there was a good percentage of the new members in the company class. As of December 31, 1951, there were about 250 sustaining members, 1735 company members, and about 4950 individual members. Adding to these the honorary, life, and junior members makes a total of 7073. Also not included in these totals were just over 600 student members at engineering schools.

The Membership Committee is hopeful that in the Society's 50th Anniversary year, there will be many other individuals, companies, and institutions, those who would unquestionably benefit from membership, who will join with us. It is recognized that one of the most important "arms" of the committee's membership promotional work is the active interest of our current members, who each year persuade many others to affiliate with ASTM.

Referring again to the accompanying curves, which are condensed for the period 1902–1930, there was a steady membership growth to about 1930, and then for about four years, a decrease (during the depression). It was about seven years, 1947 actually, before the total membership again reached the 1930 figure; but there has been a non-spectacular, though steady increase, since that period. This could be considered significant and an indication that the value of membership is becoming more widely recognized. Certainly the extensive publications, the services furnished by the Society, the meetings, and the associations made by those who participate in the work, together constitute a packet of real worth.

For one of a series of statements on "Why I am an ASTM'er," see page 14.



ASTM Bulletin

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NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Notes on 1951 Finances; A Look Ahead in 1952

Last Year's Operations Encouraging

AT THE meetings of the Board of Directors in January of each year, the Executive Secretary presents a detailed summary of the previous year's operations and also submits a draft of budget for the coming year for action by the Finance Committee and the Board. Some highlights of the report presented last month are given below. It has been the policy of the Board to provide the members with full details of the Society's operations and its condition, and these will be included in the Annual Report of the Board of Directors which will be presented to the Society at the Fiftieth Anniversary Meeting in New York the week of June 23. This report will be preprinted and distributed in advance of the meeting.

Operating Receipts in 1951:

The operating receipts for 1951, totaling $613,307, again establish a new record high. The accompanying table shows the major sources of receipts and gives comparable data for the two preceding years. It is encouraging to note that the receipts from dues increased quite markedly over the previous year and that the receipts from publications sales were also at a higher figure. A very successful year in membership growth including many new company and sustaining members, coupled with fewer losses, brought the income from dues to just over $215,000.

In reviewing income from sales of publications it is desirable to keep in mind that in one sense the Society's operations are on a three-year basis, and thus the year immediately following the issuance of the Book of Standards normally results in higher income. However, sales of the 1949 Book of Standards showed a sustained demand for this publication in its second year (1951), and the sales of special compilations and technical publications (STP's) and separate standards indicate the very favorable reception accorded these various books. It will be seen that income from dues, 35.1 per cent, together with sales of publications, 55.5 per cent, aggregated more than 90 per cent of our income. Years ago income from dues frequently was more than 50 per cent of income, so that the importance of the Society's books, in particular those involving standards, is evident in assuring a sound financial foundation for the many technical activities being carried on.

In passing it is of interest to note that in 1941 the Society's income was $199,500 and in 1931 it was $140,630. (Yes, we realize they are not the same kind of dollars, but discounting inflation and other factors the figures are still of considerable interest.)

Operating Disbursements in 1951:

With the Society's work expanding continually and publication and other costs increasing considerably, it is not surprising that the operating disbursements for 1951 are considerably higher than previously, totaling $584,199. Reference to the accompanying table will indicate that publication costs, exclusive of overhead, labor, etc., total just over $246,000, including $40,000 applied to the reserve for the 1952 Book of Standards. A growing Staff necessary to carry on the many phases of the work at Headquarters, and even then hard put at times to keep apace with them, plus salary advancements, accounted for 35.5 per cent of the disbursements. This compares with an average ratio of the five preceding years of 34.7 per cent. Thus publication and salary expenditures account for about 78 per cent of the total.

Reference might be made to the considerably higher general office expense totaling almost $60,000. The cost of handling publications has gone up sharply largely because of increased postage and expressage, and procuring a considerable stock of stationery, billing forms, and such items sent this portion considerably over the budget. Miscellaneous expenditures include the cost of new billing machines procured after considerable study, further to mechanize our operations.

The Society's contribution to the Retirement Plan for ASTM Employees was $17,289, about 3 per cent of total disbursements, and about 8.3 per cent of the salary roll; it includes for the first time the Social Security Tax totaling $2054.

Members are much interested in the

OPERATING RECEIPTS

Source	1951		1950		1949	
		Per Cent		Per Cent		Per Cent
Dues	$215 024	35.1	$205 581	34.6	$202 782	40.4
Sales of Publications	340 605	55.5	325 998	54.8	253 127	50.4
Miscellaneous						
Advertising	30 783	...	32 003	...	27 470	...
Interest and Dividends	14 365	...	9 896	...	8 849	...
Registration Fees	7 425	...	7 327	...	7 135	...
Exhibit	1 622	...	8 913	...	...	...
Other	3 483	...	4 356	...	2 685	...
Total Miscellaneous	57 678	9.4	62 495	10.6	46 139	9.2
TOTAL RECEIPTS	$613 307	100.0	$594 074	100.0	$502 048	100.0

OPERATING DISBURSEMENTS

Item	1951		1950		1949	
		Per Cent		Per Cent		Per Cent
Publications	$246 291	42.3	$231 825	44.2	$205 080	41.8
Salaries	206 959	35.5	184 250	35.2	172 732	35.1
General Office Expense	59 868	10.2	42 191	8.1	42 124	8.6
Meetings and Technical and District Committees	22 436	3.8	22 311	4.3	28 291	5.8
Headquarters Occupancy	18 618	3.2	17 535	3.4	17 694	3.6
Retirement	17 289	2.9	14 851	2.8	13 699	2.8
Miscellaneous	12 738	2.1	10 243	2.0	11 251	2.3
TOTAL DISBURSEMENTS	$584 199	100.0	$523 206	100.0	$490 871	100.0

Headquarters Building and as has been stated on a number of occasions the Society was fortunate to make the move to occupy its own building in 1946. A comparison of the operating costs which is equivalent to rent, indicates that the cost is running about $2 per square foot.

Summary of 1951 Operations:

Comparing operating receipts with disbursements there is a favorable balance just over $29,000. This was encouraging since a normal second year after publication of the Book of Standards might result in a deficit and actually budget operations must be based on the possibility of such a situation.

Assets and Net Surplus:

The balance sheet of the Society on December 31, 1951, showed assets in the General Funds of $524,491; liabilities including accounts payable and all reserve funds total $265,428, leaving a net surplus of $259,063, which is about 44 per cent of the current operating disbursements—in other words enough to run the Society for just under six months.

In addition to the General Funds, the balance sheet also shows assets in the Building Fund of $217,871 which includes depreciated value of the Headquarters Building (including land) of $160,641 and the value of the land at 1915–19 Cherry St. recently purchased at $29,179. In Special and Designated Funds, including Committee Funds, are assets of $205,314. Eliminating duplications represented by outstanding loans from the General Fund to the Building Fund, the total consolidated assets of the Society are $906,897.

Investments:

The book value of the Society's investments in all funds (*i.e.*, General, Building, Research, Committee, and Medal and Lecture Funds) was $361,915 on December 27, 1951. It will be recalled that in 1950 because of strong inflationary trends and the obvious desirability of having a larger portion of the Society's holdings in equities in relation to holdings with fixed income securities, substantial sums were invested in open-end Mutual Funds and this was continued during 1951. This has had the effect not only of much wider diversified holdings, but has had a marked effect on the income from dividends and capital gains. A year ago about 41 per cent of investments were in common stocks, whereas on December 31, 1951, the figure was about 54 per cent. Percentage in preferred stocks was the same—13 per cent—but there was a drop of from 46 to 33 per cent in the holdings of bonds.

To provide further diversification, and at the same time take advantage of higher interest rates, the Finance Committee has decided to deposit a portion of the Society's cash, especially committee funds, in several Federal Savings and Loan Associations all of which have the deposits insured in the Federal Savings and Loan Insurance Corporation up to $10,000 for each account.

Schedule of ASTM Meetings

Date	Group	Place
March 12	Committee C-3 on Chemical-Resistant Mortars	Philadelphia, Pa.
March 12	Chicago District	Milwaukee, Wis.
March 13	Philadelphia District	Philadelphia, Pa.
March 17–18	Committee D-12 on Soaps and Other Detergents	New York, N. Y.
March 18–21	Committee D-13 on Textile Materials	New York, N. Y.
March 18	Northern California District	San Francisco, Calif.
March 21	Southern California District	Los Angeles, Calif.
March 28	Committee C-18 on Natural Building stones	Washington, D. C.
March 31–April 1	Committee D-10 on Shipping Containers	Atlantic City, N. J.
April 17–18	Committee D-15 on Engine Antifreezes	Washington, D. C.
April 28	Committee C-21 on Ceramic Whiteware	Pittsburgh, Pa.
May 5–6	Board of Directors	Philadelphia, Pa.
May 13	Committee E-11 on Quality Control of Materials	Philadelphia, Pa.
May 14	New England District	Providence, R. I.
May 16 or 23	Western New York-Ontario District	Rochester, N. Y.
June 23–27	ASTM Annual Meeting—Fiftieth Anniversary (Exhibit of Testing Apparatus)	New York, N. Y.

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and locations of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

1952 Budget

In the budget for 1952, current income has been placed at $583,500, made up of dues and entrance fees of $220,000; publication sales, $290,000; miscellaneous items, $73,500.

Estimated disbursements are $629,000, made up of publication costs of $247,000; salaries (including Staff expansion and increases in salaries appropriate to meet current conditions), $224,000; and general office expenses, meetings and committees, headquarters, retirement and miscellaneous, totaling $158,000. The budget for publications makes allowance for substantial increases in cost of paper and printing. As announced, intensive work is under way in preparing for publication of the 50-Year Index to Technical Papers. This is urgently needed since there has been no index issued since 1940 and earlier indexes are out of print. The cost of issuing this has been estimated at about $7500 and to finance it money will be borrowed from the publication reserve.

Comparing the 1952 estimated income $583,500 and the anticipated expenditures of $629,000, a deficit of $45,500 is noted. In these uncertain times no one can forecast with any degree of certainty, but the budget is based on the premise of estimating receipts on the low side and disbursements on the high side. However, the Finance Committee believes this 1952 Budget is a conservative one. If the deficit develops and totals as much as budgeted, it will be met by using funds from publication and other reserves and from general surplus.

It will be evident from this brief résumé of the Society's finances, that they are in quite healthy condition. The Finance Committee will keep close watch of 1952 operations, and will make any changes in the budget that might be required by developments during the year.

President Fuller at Chicago Meeting

The ASTM Chicago District held a joint meeting with the Western Society of Engineers, at their headquarters in Chicago, Ill., on Monday evening, November 19, 1951. The meeting was opened by J. C. Harrington, Secretary of the Western Society of Engineers. R. J. Painter, ASTM Assistant Secretary, also spoke briefly of ASTM and its broad scope in technical activities. The main event of the evening, was President Fuller's address on the ever-interesting topic to engineers and technical men, "Problems in Materials," which was received with keen interest. This was followed by a showing of the film, "Jet Propulsion," developed for General Electric Co. by Walt Disney Enterprises.

ASTM 50 Years Ago

One of Our Nation's Great Technical Leaders Speaks

"Reasonableness Should Be the Spirit"

In the course of delivering his address as retiring President at the 1902 Annual Meeting of ASTM, Henry Marion Howe made a number of pertinent comments with respect to the function of the Society. In reviewing the 50 years of the Society's astonishing growth in members, activities, publications, etc., it may be appropriate briefly to consider the aims of the Society as set forth early in its career by one of its first presidents.

"What is our chief aim and object? We are members of the International Association for Testing Materials. The testing of materials has two chief features, first, the manner in which tests shall be conducted, and second, the specifications which the materials tested must endure. Of these two features the European members of the International Association in general regard the former—the manner of conducting tests—as the primary object of the Association, and the second—the reception specifications—as a thing for later consideration. But we American members, I take it, look at the matter from a radically different standpoint, and look to the erection of normal or standard reception specifications as by far the more important object. It appears to us that buyer and seller have greater difficulty in agreeing on the specifications which the material bought and sold must fulfill, than in agreeing on the methods to be used for deciding whether those specifications, once agreed on, are fulfilled by a given lot of material. We do not expect, nor do we think it important, that the standard specifications which we erect shall be exactly complied with in many, or indeed in any, actual transactions. But we are firmly convinced that the existence of such standard specifications, stamped as standards of reasonableness by a properly constituted body such as we aim to be, will greatly facilitate agreement between buyer and seller, will help them to come to terms, to convince each other that this or that item specified by one of them and objected to by the other is or is not reasonable. Reasonableness should be the spirit in which every negotiation is carried on; standards of reasonableness such as we wish to erect should greatly aid reasonable men in deciding what is reasonable. While we believe this true of domestic negotiations, we believe that it applies with even greater force to international negotiations, between buyer and seller who have never seen each other, who live under different conditions of society, with different traditions, conceptions, and points of view."

ASTM 25 Years Ago

"Statistics Don't Give the Whole Story"

The celebration of an anniversary by an organization, either technical or industrial, is an occasion on which it is almost impossible to avoid the temptation to cite numerous statistics indicating the body's growth through the period past. That such statistics do not tell the full story of any organization is well recognized, however, it is our feeling that the following quotation printed in the ASTM Bulletin on the occasion of the celebration of the 25th Anniversary of the Society is a particularly good exposition of the limitations of statistics.

"...But these statistics at best are impersonal. They do not tell of the loyal service that has been put into the Society's work in these years, nor of the fine 'esprit de corps' of our committee members who labor earnestly and effectively to further the objects for which we are organized. They do not measure the importance of the establishment of better technical and industrial relations between producer and users of materials that has been one of the outstanding accomplishments of the Society, nor show how the influence and authority of the Society throughout the engineering profession and the industries has grown with the industrial growth of the nation.

"Hence, it is fitting that we should pause on this anniversary occasion, review the past, evaluate the present, and from them gain inspiration for the future development of our Society."

Headquarters Expansion

Announcement appeared in the January ASTM Bulletin that the Society had purchased a suitable plot of ground immediately to the rear of the present building for the necessary expansion of the Headquarters. This purchase was made after careful consideration by the Board of current and future needs. Now, in order to crystallize some of the thinking and develop specific plans on the type of structure which should be built, the timing of this, and such factors, a special committee is being appointed. Dr. H. L. Maxwell, Supervisor of General Consultants, E. I. du Pont de Nemours and Co., Inc., Senior Vice-President of the Society, has accepted the chairmanship of this group. The complete personnel will be announced shortly.

This note of progress might also embody again the oft extended cordial invitation to the many members and friends of the Society to visit Headquarters. Many have done so since the building was occupied in May, 1946.

Why Am I an ASTM'er?

In the files at ASTM Headquarters are hundreds of letters which embody statements by our members on why they value ASTM. Recently a compilation of a few of the statements has been made for the new Administrative Committee on Member, Industry, and Public Relations (MIPR). A few of the "testimonials" will be used from time to time in the ASTM Bulletin.

From a Midwest Chemical Company's Chief Engineer—

...I have found the Standards of the ASTM invaluable as a source of information regarding materials with which I have had no previous experience. The publications have also been of much help in determining corrosion resistance and impact strength of materials at low temperatures. I know of no other source where one can find so much information on such a variety of materials.

We have frequently found it desirable to specify on our drawings that materials be in accordance with certain ASTM Standards such as, for example, the ones on electroplating. Furthermore, we have frequently recommended that our suppliers use the same ASTM procedures for testing materials that we use in our Inspection Department.

Our experience indicates that more industries are tending to go to the use of generally recognized specifications for materials and to use generally accepted standards for testing materials. Frequently we have to "educate" suppliers and we have found that reference to the Standards and Procedures of the ASTM is much more acceptable to our suppliers than if we provided them with an arbitrary procedure of our own.

Philadelphia District Hears Dr. Dillon Discuss Synthetic Fiber Problems

More than 150 members of the ASTM Philadelphia District and other technical people heard Dr. John H. Dillon, Director, Textile Research Institute, Inc., Princeton, N. J., present an interesting paper covering "Problems Accompanying the Introduction of the Newer Synthetic Fibers" at the District meeting on February 5 at the Philadelphia Textile Institute.

Preceding the technical session, Mr. Bertrand W. Hayward, Director of the Institute, presented the "Coffee Talk" at a dinner group of about 135. This meeting was arranged by Council member, Professor Percival Theel, Co-Ordinator of Research of the Institute. He arranged virtually all details, and though a sudden illness in the family prevented his attendance, he received many compliments on the excellent affair.

District Chairman A. O. Schaefer, Vice-President, The Midvale Co., presided at the dinner, introducing Mr. Hayward. The latter noted the establishment of the school in the 1880's; pointing out that it was the sole institution in this country concentrating on textiles that received its major support from industry and friends. Prior to the dinner, there were several guided tours through the splendid institute building. There were a number of ladies present, including wives of the councilors.

It is hoped to include an abstract of Dr. Dillon's paper in a subsequent Bulletin. He noted that newer developments in textile materials do not indicate the principal natural fibers, cottons and wool, will disappear from the scene, but that there will be a redistribution of their functions, perhaps through fiber blending. Both the natural and man-made fibers have their weaknesses, and long-range scientific research can provide important data to take full advantage of natural properties. He discussed in detail the basic elements in the success of a fiber, namely availability, price, and superior properties, and reviewed some of the fiber and yarn problems related to uniformity, specific gravity, strength, extensibility, creep, resilience, moisture absorption, dyeability, also chemical stability and surface characteristics.

Dr. Dillon

He referred to fabric problems brought about by man-made fibers, reviewing briefly such problems as mechanical stability, soiling, ironing range, local melting, flammability, piling, static electrification, wicking, felting, abrasion, crease resistance, and tactile qualities.

He concluded:

"I do hope that I have established the magnitude and variety of the research and development effort which must be expended to solve these problems. Solving this set of problems will undoubtedly create others. I believe, furthermore, it is clear that both fundamental and applied research will be necessary and that a good portion of it will go into improvements in the natural fibers which are far from obsolete. In fact, there is a growing conviction that one of the results of increased use of the man-made fibers will be the discovery of new uses for the natural fibers. Certainly, there will be increased effort to expand the utilization of the natural fibers through scientific research and marketing studies.

"As the textile 'volcano' gradually reaches its final stage of eruption, the textile industry stands to profit greatly by the opportunity of having at its disposal an almost unlimited variety of raw materials with a concomitant stabilization of raw material price structure. The textile industry must realize its obligation to contribute to this metamorphosis by expanding its own applied research programs and supporting fundamental research at P.T.I., T.R.I., and other academic institutions; the greater this contribution, the greater will be its benefit from the volcanic changes which are only now beginning to take place."

Operations Research

In order to evaluate the desirability of a general meeting on the subject of "Operations Research," the Philadelphia District Council recently had an informal meeting with Arthur A. Brown, Executive Secretary, Committee on Operations Research, of the National Research Council. A leader in this field, he had done much work on it in the Navy during World War II. He brought out many interesting points. This relatively new field (although some might feel that their activities were certainly very close to the basic concept of "Operations Research") has been defined as a "Scientific Method for Providing Executives with a Quantitative Basis for Decisions." This type of research was used effectively on many problems in World War II, for example, combating U-boat operations in the Bay of Biscay, and methods of overcoming the kamikazi attacks of the Jap air force.

An interesting brochure has been issued by the Committee on Operations Research of the National Research Council, and copies can be procured by writing N.R.C., 2101 Constitution Avenue, Washington 25.

In New York

The "End" Results of Specifications

WITH respect to the extensive use of ASTM Standards in the New Jersey Turnpike, referred to in an article in this BULLETIN, it obviously would not be correct to say that this turnpike resulted because there were standards. On the other hand it is quite clear that this impressive new highway, which will be of such great service to so many people, is a very tangible end result of many specifications and standard test methods.

Frankly, it gives us a "good" feeling to record, through the close cooperation of one of our very long-time members—a leading commercial testing laboratory—just how many ASTM standards were used to govern the quality and testing of the amazing variety of materials going into the highway and its appurtenant buildings and facilities.

There are some consolations to ease a few of the tribulations always experienced by our technical committee members and officers in their work—including the respect of many others in industry for persevering in these essential activities, the fellowship with men doing the work, the realization that industry and many branches of government would be hard put to operate without authoritative standards; but we just feel certain somehow, that a great many technical committee men will derive—as we did—much satisfaction from a review of the accompanying article on the New Jersey Turnpike.

President and Executive Secretary on West Coast Trip

IN MARCH, following a meeting in Milwaukee, at which President Fuller is the speaker, a session jointly sponsored with the Milwaukee Section of the American Society of Mechanical Engineers (date: March 12; place: Engineers Society of Milwaukee), the President will journey to the West Coast, where he is scheduled to speak at joint meetings in San Francisco (March 18), and in Los Angeles (March 21). Following the Southern California meeting, the President will go to Richland, Wash., where he will address a joint meeting of all the engineers at the Hanford atomic plant.

Executive Secretary C. L. Warwick will meet President Fuller in San Francisco, and join him in the program there and in Los Angeles. Mr. Warwick is then returning directly home.

The two West Coast Districts have been most anxious to have the President and Executive Secretary visit them. Details of these meetings are listed in the accompanying table.

"Reasonableness Should Be the Spirit" see "50 Years Ago" on page 12

Plan to be present at the following meetings in your area. Everyone is cordially invited.

New York, Pittsburgh, Cleveland, Milwaukee, Philadelphia, San Francisco, Los Angeles, Providence, and Detroit Districts.

District	*Date*	*Place*	*Subject*	*Speaker*
New York	February 29	Engineering Societies Bldg., Room 502, 29 West 39th St., New York, N. Y.	"Factors in Corrosion with Respect to Design and Lubrication Problems" (Joint meeting Machine Design Div., ASME, and New York Sec., American Society of Lubricating Engineers)	F. L. LaQue, in Charge of Corrosion Engineering, Development and Research Div., International Nickel Co.
Pittsburgh	March 3	Mellon Institute, Pittsburgh, Pa.	"Role of Boron Steel in the Present Emergency"	Porter R. Wray, Metallurgical Engineer, United States Steel Co., Pittsburgh, Pa.
Cleveland	March 5	Hotel Statler, Cleveland, Ohio. Dinner and Technical program	(1) "Solving Problems in Materials"	(1) ASTM President Truman S. Fuller, Engineer in Charge of Works Laboratory, General Electric Co., Schenectady, N. Y.
			(2) "Engineering for Radioisotopes" (Film)	(2) A. F. Rupp, Supt., Radioisotope Development Dept., Oak Ridge National Laboratory
Chicago	March 12	Engineers Society of Milwaukee Bldg., 3112 W. Highland Blvd., Milwaukee, Wis.	"Solving Problems in Materials" (Jointly with Milwaukee Section, American Society of Mechanical Engineers)	ASTM President Truman S. Fuller
Philadelphia	March 13	Auditorium, Franklin Institstitute, Philadelphia, Pa.	"Industrial Uses of Television"	M. C. Banca, Radio Corporation of America, Camden, N. J.
Northern California	March 18	Marine Memorial Bldg., Room 401, 609 Sutter St., San Francisco, Calif.	"Solving Materials Problems in the Electrical Manufacturing Industry"	ASTM President Truman S. Fuller
			"European Aspects of Standardization and Testing of Materials" (Joint meeting with San Francisco Section, American Institute of Electrical Engineers)	C. L. Warwick, Executive Secretary, ASTM
Southern California	March 21	Los Angeles, Calif.	"Solving Materials Problems in Industry"	ASTM President Truman S. Fuller
Detroit	April 28	Rackham Memorial Bldg., 100 Farnsworth Ave., Detroit, Mich.	"Power from Atomic Energy"	Panel of four experts from Detroit Edison—Dow Chemical Food Study Group
New England	May 14	Providence, R. I.	"Solving Materials Problems in Industry"	ASTM President Truman S. Fuller

Many ASTM Standards Used in New Jersey Turnpike

Host of Materials Used in Splendid New Highway Covered by Standard Specifications and Tests

Not only is there great interest on the part of individual members of the Society in the recently completed New Jersey Turnpike but there is an official interest, so to speak, because of the widespread use by the New Jersey Turnpike Authority of a host of ASTM specifications, methods of tests, and definitions covering the wide variety of materials going into the Turnpike and its appurtenances.

Through the courtesy of the Engineering and Inspection Division, United States Testing Company, a long-time ASTM member, which had the responsibility for inspecting and testing of steel, concrete, pipe, and other materials, we have been furnished a list of ASTM standards used by the Authority. This imposing list of standards is a very practical demonstration of the important application of work resulting from the intensive efforts of our many committee members.

Since a number of journals have had articles featuring the Turnpike, including the January issue of *Civil Engineering*, to whom we are indebted for some of the following information and for the loan of the cuts illustrating this article, only brief data are given here.

Completed at a cost of 255 million dollars, the Turnpike makes it possible for motor vehicles to travel for some 118 miles from the George Washington Bridge in New York to the new Delaware Memorial Bridge near Wilmington, Del.

As *Civil Engineering* points out, the Turnpike—the first major construction contracts for which were awarded in December, 1949—is a monument to the 700 engineers and 10,000 others who had a part. This included many ASTM members and member companies, some of whom had responsibility for testing and inspection of materials used in the Turnpike other than those mentioned above covered by United States Testing.

The expressway was financed by revenue bonds without any Federal or State aid or other subsidy and the toll rates which are in effect are about one cent a mile for the 83 miles at the south end and about three cents for the northern 35 miles. For the total passage, the passenger car toll is $1.75.

Much more might be written about this tremendous engineering achievement—of the design features, the problems of procuring the right of way, of handling the millions of tons of material that went into the construction, of the unique equipment used (one estimate of which indicates that its value was around 45 million dollars)—but the various stories and, in fact, the full story has been well handled by other engineering journals.

List of ASTM specifications, methods of tests, and definitions used by the New Jersey Turnpike Authority, and in certain supplementary specifications. Titles and designations are abbreviated.

Note: It is realized that this list may not be complete but it is felt reasonably to be so.

Ferrous and Non-Ferrous

ASTM	
A 7	Structural Steel
A 15	Concrete Reinforcement
A 27	Steel Castings
A 41	Iron Bars
A 42	Wrought Iron Plate
A 43	Foundry Pig Iron
A 44	Heat Treatment of Metals
A 47	Malleable Iron Castings
A 48	Iron Castings
A 53	Steel Pipe
A 72	Wrought Iron Pipe
A 73	Wrought Iron Rolled, Blooms and Forgings
A 94	Structural Steel (Silicon)
A 105	Steel Pipe Flanges
A 116	Zinc-Coated Fencing Material
A 117	Zinc-Coated Fence Fabric
A 122	Zinc-Coated Wire Strands
A 123	Galvanizing (Hot Dip)
A 139	Electric Welded Steel Pipe
A 141	Structural Rivet Steel
A 148	Alloy Steel Castings
A 152	Wrought Iron Rivets
A 153	Zinc-Coating on Hardware
A 158	Seamless Alloy Steel Pipe
A 167	Chromium-Nickel Steel Plate, Sheet and Strip
A 185	Reinforcement (Wire or Mesh)
A 196	Terms Relating to Cast Iron
A 207	Wrought Iron Shapes and Bars
A 233	Mild Steel, Welding Electrodes

Cuts courtesy *Civil Engineering*

An unusual photograph is obtained as a haunch girder of the Turnpike's Passaic River Bridge is lifted into place.

Laying of the first course of bituminous concrete near North Camden interchange.

A 235 Carbon Steel Forgings
A 237 Alloy Steel Forgings
A 239 Uniformity of Galvanized Articles
A 246 Steel Sheets
A 256 Compression Tests, Cast Iron
A 285 Carbon Steel Plates
A 298 Welding Electrodes
A 316 Low Alloy Arc Electrodes
B 8 Electrical Cables
B 22 Bronze (Cast)
B 100 Bronze (Rolled)

Cementitious, Ceramic, etc. ("C" Group)

C 29 Unit Weight of Aggregates
C 30 Voids in Aggregates for Concrete
C 32 Sewer Brick (Clay or Shale)
C 33 Concrete Aggregates
C 39 Making and Curing Concrete Test Specimens
C 40 Organic Impurities in Sands for Concrete
C 55 Concrete Building Block
C 67 Sampling and Testing Brick
C 75 Reinforced Concrete Sewer Pipe
C 76 Reinforced Concrete Culvert Pipe
C 88 Soundness of Aggregates
C 109 Compressive Strength of Cement Mortar
C 114 Chemical Analysis of Cement
C 115 Fineness of Cement
C 117 Amount of Material Finer than No. 200 Sieve
C 123 Coal and Lignite in Sand
C 125 Concrete Mix Design
C 127 Specific Gravity and Absorption of Coarse Aggregates
C 128 Specific Gravity Fine Aggregates
C 131 Abrasion Test for Coarse Aggregate
C 136 Sieve Analysis of Aggregates
C 138 Weight per cu ft Yield, and Air Content of Concrete
C 142 Clay Lumps in Aggregates
C 143 Slump Test for Consistency
C 150 Portland Cement
C 151 Auto-clave Expansion of Cement
C 156 Curing Concrete
C 171 Paper for Curing Concrete
C 172 Sampling Concrete
C 173 Air Content of Concrete
C 175 Air Entraining Portland Cement
C 183 Sampling Hydraulic Cement
C 187 Consistency of Cement
C 191 Setting Time
C 192 Specimens of Concrete
C 289 Abrasion of Coarse Aggregates

Miscellaneous Materials ("D" Group)

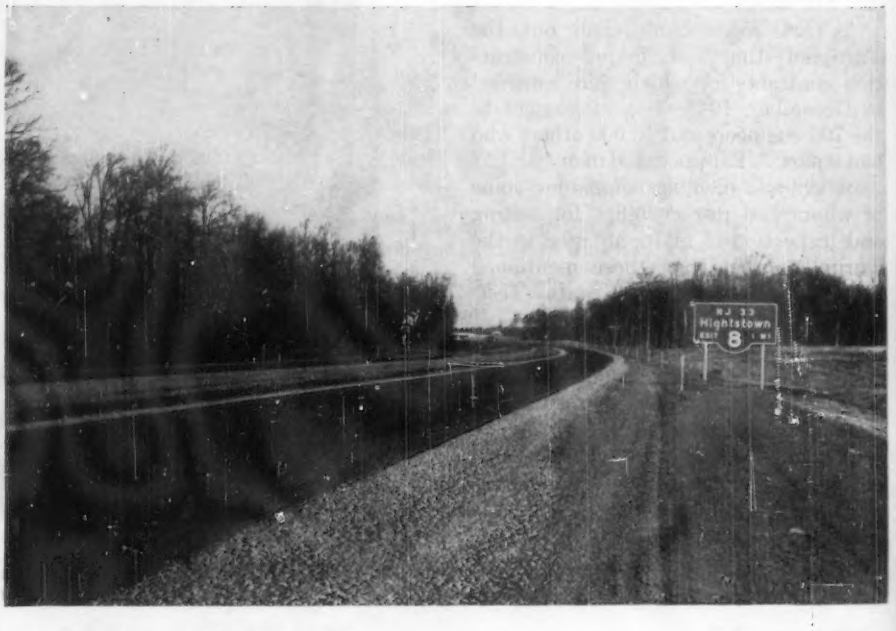
D 4 Determination of Bitumen
D 5 Test Methods, Hot Extraction
D 6 Loss on Heating of Asphaltic Compounds
D 34 Chemical Analysis of Pigments and Pastes
D 36 Softening Point of Bituminous Materials
D 41 Primer for Use with Asphalt
D 61 Softening Point of Tar Products
D 70 Specific Gravity of Asphalts, Tar, etc.
D 71 Specific Gravity of Solid Asphalts, etc.
D 75 Sampling Stone, Slag, Gravel, Sand
D 79 Zinc Oxide (Lead Free)
D 83 Red Lead (95 per cent)
D 84 Iron Oxide
D 88 Viscosity Test (Saybolt Viscosimeter)
D 92 Flash and Fire Points
D 93 Test for Flash Point
D 95 Water in Petroleum Products
D 98 Calcium Chloride
D 113 Ductility of Bituminous Materials
D 139 Float Test for Bituminous Materials
D 146 Testing Felted and Woven Fabrics
D 153 Specific Gravity of Pigments
D 165 Proportion of Bitumen
D 185 Coarse Particles in Pigments, Pastes and Paints
D 206 Volume Correction Table for Petroleum Oils
D 209 Lamp Black
D 234 Linseeed Oil
D 235 Thinner (Mineral Spirits)
D 243 Residue of Specified Penetration
D 255 Distillation of Bituminous Protective Coatings
D 261 Iron Blue Ferric-Ferrocyanide
D 387 Mass, Color, and Tinting Strength of Pigments
D 402 Distillation of Cut Back Asphaltic Products
D 420 Sampling Soils for Highway Subgrades
D 421 Preparing Soil Samples
D 423 Liquid Limits of Soils
D 424 Plastic Limit and Plasticity Index of Soils
D 476 Titanium Dioxide
D 480 Sampling Aluminum Powder and Pastes
D 490 Road Tar Requirements
D 520 Zinc Dust
D 561 Carbon Black
D 564 Liquid Dryers
D 574 Ozone Resistance Insulation (Electrical)
D 600 Liquid Paint Dryers
D 602 Barium Sulphate
D 605 Magnesium Silicates
D 698 Moisture Density of Soils
D 752 Electrical Cable Insulation
D 762 Hot Extraction Asphaltic Materials
D 854 Specific Gravity of Soils
D 962 Aluminum Pigment

California Road Conference Proceedings

Proceedings of the Third California Conference on Street and Highway Problems, recently published by the Institute of Transportation and Traffic Engineering, University of California, include 34 papers on construction, maintenance, traffic, county, urban, and general road developments. Two of the papers deal in detail with important aspects of national defense and one with the application of hydraulic principles to the design of both small and large structures. The Institute of Transportation and Traffic Engineering staff have contributed a seven-page summary of their research activities.

The 132-page *Proceedings*, 8½ by 11 in., paperbound, are available from University Press, University of California, Berkeley 4, for $1.

A typical scene of the New Jersey Turnpike near Hightstown.



More Unsolved Problems

Additional Research Projects from ASTM Committees

THE January issue of the BULLETIN contained the first of a series of unsolved research problems submitted by the various technical committees of the Society.

As indicated previously, it is planned to publish five of these problems in each succeeding issue of the BULLETIN until all the problems submitted have been published in this form. In the meantime, all of the problems will be grouped together according to committee, printed in the form of a pamphlet, and distributed to various engineering and science schools, research institutes, and testing laboratories as a suggested basis for possible research work.

The research problems published in January were:

The Durability of Concrete
Constitution of Lignin
Test for Rapid Appraisal of Weatherability of Asphalts
Fatigue Strengths of Metals Subjected to Combined Stresses
The Effect of Various Factors on the Fatigue Life of Materials

This issue includes:

Particle Size of Hydrated Limes
Can Mortar Properties Be Improved by More Thorough Mixing?
Non-Destructive Tests for Wood
Temperature and Humidity Measurements on Asphaltic Roofing Materials
Study of Crack Genesis and Growth in Steel

Particle Size of Hydrated Limes

Statement of Unsolved Problem Contributed by Committee C-7 on Lime

Problem:

In practically all industrial uses of hydrated lime, the particle size, or some property related to particle size, is of fundamental importance yet it cannot be readily measured.

Present State of Knowledge:

While practically all specifications for hydrated lime require a fineness determination, usually on a No. 200 (74 micron) sieve it is known from the work of Bishop (Reference 1) that the product passing a No. 200 sieve is composed primarily of particles having apparent diameters of less than 5 microns. Staley and Greenfeld (Reference 2) showed, by nitrogen adsorption methods, that the surface areas of hydrates ranged from 7 to 46 sq meters per gram. The higher of these figures indicate particle diameters of less than 0.1 micron.

Questions That Need to Be Answered:

Neither the method of Bishop (1) nor that of Staley and Greenfeld (2) is adaptable to a quick estimation of the particle size of hydrated lime. A method is needed for measuring the particle size, or some property directly related thereto, rapidly and with reasonable accuracy. This method might be analogous to the Wagner turbidimeter used with portland cement.

Introductory References:

(1) Dana L. Bishop, "A Sedimentation Method for the Determination of the Particle Size of Finely Divided Materials (Such as Hydrated Lime)," *Journal of Research*, Nat. Bur. Standards, Vol. 12, p. 173 (1934).

(2) H. R. Staley and S. H. Greenfeld, "Surface Areas of High-Calcium Quicklimes and Hydrates," *Proceedings*, Am. Soc. Testing Mats., Vol. 47, p. 953 (1947).

Additional information may be obtained from J. A. Murray, Room 7-006, Massachusetts Institute of Technology, Cambridge 39, Mass.

Can Mortar Properties be Improved by More Thorough Mixing?

Statement of Unsolved Problem Contributed by Committee C-12 on Mortars for Unit Masonry

Problem:

To determine the beneficial results of high-speed mortar mixing.

Present State of Knowledge:

Preliminary laboratory and one field trial indicate that a mixing rate above 200 rpm improves most of the properties coming under the heading "workability" by about 25 per cent. The working time of the mortar is also increased, a point of great practical importance in hot weather; also in tile setting.

Questions That Need to Be Answered:

More field evaluation is needed, backed up by independent laboratory work.

Introductory References:

An informal report was made by F. O. Anderegg to Committees C-7, C-12, and the Sponsoring Subcommittee of C-1 on Masonry Cements at the Fifty-Third Annual Meeting of ASTM in Atlantic City, N. J., June 26–30, 1950.

Additional information may be obtained from J. M. Hardesty, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

Non-Destructive Tests for Wood

Statement of Unsolved Problem Contributed by Committee D-7 on Wood

Problem:

To develop rapid practical non-destructive tests for closely evaluating the strength of individual pieces of timber containing knots and other natural characteristics as an effective means of improving the efficiency of structural timber utilization.

Present State of Knowledge:

Individual pieces of wood of any species exhibit a wide range in strength properties. Present methods of structural grading, based on an evaluation of the physical characteristics through visual inspection, afford safe and effective structural grades. However, any structural grade to which working stresses are assigned must reflect the strength of the minimum quality of material in the grade, and consequently contains substantial quantities of higher strength material that is used inefficiently at a lower stress level than it is capable of carrying. The development of non-destructive tests for more closely evaluating the strength of individual pieces of timber would greatly improve the efficiency of timber utilization and permit substantial increases in working stresses.

Many data are available on the effect of various characteristics and defects on the strength of timber, and basic principles for structural grades based on the evaluation of physical characteristics by visual inspection have been developed, as presented in ASTM Method D 245 – 49 T, "Tentative Methods for Establishing Structural Grades of Lumber" (1). Study has been made of the relation of density to strength. It has also been shown that a relation exists between the slope of fibril and strength and between the slope of fibril and longitudinal shrinkage. Methods have been developed for evaluating strength by sampling and testing. Also, some progress has been made in the development of hardness test methods for use in estimating quality. Further studies have shown the possibility of evaluating modulus of elasticity by non-destructive sonic methods and indicate that the compressive strength may be related to the logarithmic decrement of the vibrations.

Questions That Need to Be Answered:

The basic need is for a non-destructive test method that can quickly be applied to individual pieces of timber, as they flow from the production line, and that will permit an accurate estimate of the strength of individual pieces, thereby permitting classification with respect to appropriate working stress.

Introductory References:

(1) ASTM Method D 245 – 49 T, "Tentative Methods for Establishing

Structural Grades of Lumber," 1949 Book of ASTM Standards, Part 4, p. 589.

(2) U. S. Dept. Agriculture, "Strength and Related Properties of Woods Grown in the United States," *Technical Bulletin No. 479.*

(3) R. F. S. Hearmon, "Elasticity of Wood and Plywood," Great Britain Department of Science and Industrial Research, *Forest Products Laboratory Special Report 7*, London (1948).

(4) G. Kitazawa, "Non-Destructive Testing of Forest Products," Timber Engineering Co.

Additional information may be obtained from L. J. Markwardt, U. S. Forest Products Laboratory, Madison 5, Wis.

Temperature and Humidity Measurements on Asphaltic Roofing Materials

Statement of Unsolved Problem Contributed by Committee D-8 on Bituminous Waterproofing and Roofing Materials

Problem:

Asphaltic materials are affected by heat and moisture. The viscosity and the rate of oxidation change with temperature, and moisture affects the durability of the asphaltic roofing materials.

Present State of Knowledge:

At the present time 140 F is considered as an approximation of high roof temperatures. Such information, however, is incomplete and does not give any information regarding rapid fluctuations, nor on the duration of the maximum temperatures. No information is available on humidities.

Questions That Need to Be Answered:

Temperatures should be taken the year round or at least at the most intense periods of the various seasons as follows:

1. At surface of granules.
2. In the coating.
3. At interface of coating and saturated felt.
4. In the center of the saturated felt.
5. Between the specimen and the roof deck.

Humidities should show air humidity on the roof. Suitable recording instruments for measuring temperatures would be needed and the tests should be made in selected geographical locations.

Additional information may be obtained from H. R. Snoke, National Bureau of Standards, 2707 Industrial Bldg., Washington 25, D. C.

Study of Crack Genesis and Growth in Steel

Statement of Unsolved Problem Contributed by Committee E-9 on Fatigue

Problem:

There is experimental evidence that test bars having extremely high stress concentration may show cracks at stress levels well below the endurance limit for such test bars. More information is required on this aspect of the fatigue problem.

Present State of Knowledge:

Tests in rotary bending show that for the case of a sharp notch in low-carbon steel and with an endurance limit of ±26,000 psi cracks may be developed at stress levels as low as 10,000 psi. Whether or not such cracks spread has not been clearly established due to the difficulty of determining the presence of cracks of a depth of 0.001 in. or less. Similar results have been obtained for much larger specimens under cyclic direct stress. A great deal of data are also available on the growth of cracks at press fit assemblies.

Questions That Need to Be Answered:

1. Under what conditions will cracks develop and will these be the same for carbon and alloy steels?
2. Under a constant range of stress these cracks may not spread but under a condition of high peak stresses is this still true?

Introductory References:

(1) J. M. Lessells and H. E. Jacques, "Effect of Fatigue on Transition Temperature of Steel," *Welding Research Supplement*, Am. Welding Soc., Vol. XV, No. 2, February, 1950.

(2) H. F. Moore, "A Study of Fatigue Cracks in Car Axles," *Bulletin No. 165*, Engineering Experiment Station, University of Illinois, Urbana, Ill. (1927).

(3) C. E. Phillips and R. B. Heywood, "The Size Effect in Fatigue of Plain and Notched Steel Specimens Loaded Under Reversed Direct Stress," presented at the Institution of Mechanical Engineers, London, February 23, 1951.

(4) O. J. Horger and T. V. Buckwalter, "Fatigue Strength of Normalized and Tempered *versus* As-Forged Full Size Railroad Car Axles," *Transactions*, Am. Soc. Metals (1942).

Additional information may be obtained from T. J. Dolan, Talbot Laboratory, University of Illinois, Urbana, Ill.

BPA Head Says Non-Ferrous Scrap Shortages as Critical as Steel

At a recent Business and Trade Press emergency conference the administrator of the Defense Production Administration and National Production Authority summarized the progress made in the recent campaign to recover iron and steel scrap. Mr. Fleischmann pointed out that great strides had been made in the campaign but that renewed effort would be necessary if full defense production was to be maintained. Of particular interest in Mr. Fleischmann's speech was his reference to the shortages in non-ferrous scrap and the collection of critically short scrap metals from organizations not directly connected with the metals field. On these subjects Mr. Fleischmann said in part:

> "We have stressed the iron and steel scrap shortage because of the tremendous quantity of material involved, but I must hasten to add that the shortages of non-ferrous scrap—particularly copper, brass, bronze, aluminum, lead and zinc—are just as critical. It takes many materials to build this defense production output, and if we allow the scrap shortage in these metals to get any worse, there will be far-reaching effects on the total program. The urgency that applies to iron and steel scrap recovery applies in equal measure to non-ferrous scrap. In fact, we must go even further in this field, as the efforts to recover non-ferrous scrap, being less dramatic, have not yet received attention comparable to that given to the iron and steel scrap effort...
>
> "Without going into details, I would like to outline the three steps that must be taken immediately:
>
> "*First*—we just intensify the present iron and steel scrap recovery program.
>
> "*Second*—we must launch the non-ferrous aspects of scrap recovery so that we salvage not alone iron and steel scrap but also every possible pound in the critically short areas of copper, brass, bronze, aluminum, lead and zinc.
>
> "*Third*—we must expand the over-all program far beyond the obvious sources of such scrap so we include those which are less obvious...
>
> **"The theme is this: Wherever there is business, there is scrap.**
>
> "Unfortunately, there are many business people who feel they can be of little or no assistance in this program because they manufacture or handle non-metal goods. They must be convinced that they *do* generate scrap and that, although in some cases the quantity of salvage in an individual firm may seem small, in the aggregate they represent very real volume which at this time of critical shortages is essential to the defense production program."

Knock Rating of Small Samples

By R. H. Stacey[1]

THE ASTM Motor and Research Methods for the determination of knock characteristics of motor fuels generally require a sample volume of at least 450 ml for each of the methods. This amount, particularly in research and pilot plant work, often means costly repetition of experiments to make a large enough sample for engine tests. To overcome this difficulty many laboratories tried blending the unknown sample with fuels of known octane number and determined the octane number of the blend. Unfortunately, most fuels do not blend linearly with regard to octane number, and the use of empirical correction tables or charts could only be used with fuels of known type to estimate the octane number of the unblended fuel. Other methods tried involved reducing the "hold-up" of the sample in the carburetor of the test engine by means of special float bowls or pipets, in place of the regular fuel containers. By "hold-up" is meant the volume of fuel required to fill the lines and carburetor to make the system function properly but fuel which is not actually consumed in the engine. Notable contributions were made to these methods by the Tide Water Associated Oil Co.,[2] the Standard Oil Co. (Ohio),[2] and the Houdry Process Corp.[3]

In June, 1949, a group known as the Micro-Method Study Group was formed under Section C of Research Division I on Combustion Characteristics of ASTM Committee D-2 on Petroleum Products and Lubricants to recommend a procedure for the testing of small samples by the Research and Motor Methods. The need for such a method was further emphasized by the desire of Research Division I to use an engine test to detect impurities (which affect the octane number) in the ASTM primary reference fuels. It is desirable to compare new batches of these reference fuels with official standards directly in an engine and in the interest of conserving the expensive standards a small sample method is valuable.

After reviewing existing procedures and trying different fuel systems and various instruments for recording the knock, it was apparent that the small sample method would require (1) a fast response of the knockmeter while the fuel is passing through its air-fuel ratio for maximum knock and (2) a very small "hold-up" of the sample in the fuel system.

Detonation Meter, Model 501, was modified to give a variable response by means of a six-point switch on the short time constant instead of a two-point switch. This modification may easily be made to Model 501 and is incorporated in the later model, 501A. Both models are optional equipment for the bouncing pin in the ASTM Motor and Research Methods.

Modifying the fuel system to reduce sample "hold-up" proved difficult as some of the Micro-Method Study Group preferred a pipet and others a small float bowl. A multi-pipet system was proposed with some differences in procedure from that used with a single pipet. In all three fuel systems the "hold-up" of fuel is reduced so that tests can be run on 40 to 50 ml samples.

Cooperative tests were run in six laboratories using both the small float bowl and single pipet fuel systems. Various fuels were tested, including the six ASTM proof-test fuels made available for such work. The results showed that the precision by the two fuel systems was about the same. Later, tests in individual laboratories indicated that the multi-pipet system was equivalent in precision to the other systems. The multi-pipet also saved time in changing fuels.

On the basis of the standard deviations obtained in the cooperative tests on the same fuels and engines, the accuracy of the Micro-Methods (Motor or Research), using any one of the three proposed fuel systems, is not quite as good as that for the standard ASTM Methods in the range of commercial gasolines.

Octane numbers can be determined in less time with the small sample methods than with the ASTM Methods, and several laboratories are using them for routine samples even when sample volumes are sufficient for the standard ASTM Methods. In such cases the size of the sample should be increased to 100 ml or more as this amount requires less dexterity on the part of the operator.

Details of the methods with the three different fuel systems which will permit determination of the knock rating of samples of 50 ml volume were published for information only in the September, 1951, issue of ASTM Standards on Petroleum Products and Lubricants, Appendices VI and VII, pages 727 and 736.

[1] Leader of Micro-Method Study Group, Esso Laboratories, Standard Oil Development Co., Linden, N. J.

[2] "Report on Rating Small Samples of Motor Gasoline," Coordinating Research Council, Inc., May 21, 1948.

[3] J. Alexander and G. Pfeiffer, "Micro Determination of the Knock Characteristics of Motor Fuels," Joint Symposium on Micro Chemistry, Am. Chem. Soc., April, 1949.

Copies of Part 1, 1949 Book of ASTM Standards, are still needed. Reprinted below is a box explaining this need. Many of our members and others having this book were able to return their copies to Headquarters. Will you evaluate this situation?

Needed: Copies of Part 1—Ferrous Metals, 1949 Book of Standards

IT IS quite apparent that before many weeks the stock of Part 1—Ferrous Metals, 1949 Book of Standards, will be in a very low state. Present available copies of the book are such that we can continue to meet the demand for it through February, at least, but there is no slackening in the orders for the book and, of course, many of the new members request this part on their membership. So that we can fill urgent orders for Part 1 after the current supply is exhausted, a plea is being made to members and other purchasers, who may not have constant need for the book to sell their copy to the Society. We will buy back copies of 1949, Part 1, at $4 each, it being assumed the book would be in reasonable condition for resale.

Members and purchasers may be able to meet their needs through other copies in their organizations, through some one of the special compilations that have been issued (pipe and tubing, plates, structural, bars, etc.), or through the 1950 and 1951 Supplements to Part 1 which contain all of the 1950–51 standards in their latest form.

Those who are willing to dispose of any copies of Part 1, 1949 Book of Standards, may send these books to ASTM Headquarters. Be sure a return address is on the package to enable identification, and better still, also advise that shipment is being made. If the check should be made payable to any special account or name, this should be stated clearly.

(There is an ample supply of Supplements to Part 1—hence, there is no need to buy back any of these.)

TECHNICAL COMMITTEE NOTES

Notes on Four-Day Meetings of Committee A-1 on Steel

Emergency Provisions, Impact Testing, New Specifications Reviewed at Philadelphia January Meetings; New Honorary Members

A NUMBER of important actions took place at the four-day series of meetings of Committee A-1 on Steel in Philadelphia at the Hotel Benjamin Franklin, January 28 to 31, inclusive. In addition to so-called regular revisions and several new specifications which will be offered to the Society later, several emergency provisions were approved for letter ballot. There was also a technical paper on impact testing which created much interest. Notes of specific subcommittee work follow.

Structural.—An action of Subcommittee II will interest those concerned with structural steel; namely, the modification of the elongation requirements on relatively thin materials, that is, below $^5/_{16}$ in. in thickness. The committee is inserting in General Requirement Specification A 6 permission to select a specimen at random for retest. Also there is to be inserted in the structural steel purchase specification, A 7, a reference to the use of malleable iron where agreement has been reached, very probably listing grade 35018. This standard is unusual in that it covers by reference to other specifications quite a number of materials used with structural steel, so that it is virtually complete for a structural engineer's requirements.

Forgings.—Much activity is evident in the field of forgings, covered by Subcommittee VI. There was clarification of certain size classifications in the General Forgings Specifications, A 235, A 236, and A 237. Several existing standards were reviewed and reaffirmed in their present form. There has been a marked difference of opinion on proposals to set up check analysis requirements in the carbon and alloy billet Specifications A 273 and A 274, and although there still is not a complete meeting of minds, the committee voted to have ASTM issue in tentative form the new versions of these specifications. Following procurement of one or two more illustrative photographs an important new document covering macroetch testing will be offered for publication. A special group has spent many months seeking out appropriate illustrations of the various defects and it is now satisfied. Progress was reported in developing an ultrasonic test method and also requirements for forged light-weight pressure vessels.

In the work on mechanical testing procedures for forgings virtual agreement was procured.

Castings.—After much discussion in Subcommittee VIII among the producers and consumers of a special type of steel casting used for steam turbines, a proposed specification for heavy-walled carbon and low-alloy steel castings for steam turbines is now to be balloted upon. This ferritic material is used for cylinders, valve chests, throttle valves, and other heavy walled castings for steam turbine applications. Some changes were recommended in the widely used general Specifications A 27 involving unspecified alloying elements.

Pipe and Tubing.—Perhaps of paramount interest in Subcommittee IX and the piping section of XXII covering this material for high temperature service was the decision to rush emergency provisions permitting conservation of molybdenum. On the nominal $^1/_2$ per cent Mo grades a minimum limit of 0.40 will be set up, and for the nominal 1 per cent grades a minimum limit of 0.80.

In Specifications A 213, A 249, A 269, and A 271 it is recommended that the requirements for passivation be removed.

In the widely used Specification A 53 covering various types of seamless and welded pipe, inadvertently a section had been incorporated requiring that the hydrostatic test be held for 5 seconds. Although this was reported causing the butt-weld mills considerable trouble because of the speed of that operation, many users were reluctant to have it eliminated, but when it was noted that on the larger sizes it was current practice to hold the test for the 5-second period, a compromise was effected whereby the smaller sizes (that is, below about $2^1/_2$ in.) of butt-weld material will not require the holding time, simply bringing up the pressure.

A revision in the hardness requirements of the high silicon grades in A 213 was proposed. Work is continuing in developing standard grade symbols for all specifications.

Plates for Pressure Vessels.—The Subcommittee on Steels for Boiler Pressure Vessels concerned largely with plate material, revised its $8^1/_2$ per cent nickel specification in connection with some adverse comments and satisfied these. A revised draft of a 4 to 6 per cent Cr steel plate was approved for letter ballot. A grade of $2^1/_2$ Cr 1 per cent Mo plate to be used in conjunction with the requirements in the ferritic plate Specification A 335 was authorized. A working group was appointed to prepare a specification for carbon steel plates resistant to graphitization at 900 F. for use in the petroleum and associated industries.

Methods of Testing.—One of the important projects in the steel committee under the guidance of Subcommittee XIII on Methods of Testing is to prepare a Manual with standard procedures for testing steel products. The various methods for evaluating mechanical properties, while in general similar for the respective grades of steel products, contain sufficient variations peculiar to specific products that Subcommittee XIII asked each specification group to prepare a draft. One of these has been published, A 330, covering bar steel. Drafts have been completed covering structural steel, pipe and tubing, forgings, and others, and now an intensive effort is to be made to coordinate these with the thought of reasonably prompt publication. The whole would constitute a manual on the mechanical testing of steel products.

The interest in impact testing was evident by attendance of over 125 at the Subcommittee XIII meeting when Humphrey L. Fry (a son of Lawford Fry, who was very active in ASTM and Committee A-1 work for many years) gave his paper on impact testing. This involved intensive study of different impact machines in the Bethlehem organization and data on the attempts made to correlate the results. While the last word has not been said, it is obvious this test does need further study. This paper is to be presented at the Annual Meeting of the Society when there will be more discussion.

Bar Steels.—A task force has been appointed to review the application of boron treated steels to the various ASTM bar steel specifications and consider emergency alternate provisions, if found practical. A new specification for nitriding steel has been approved by Subcommittee XV and has been given to Committee A-1. Certain Bessemer equivalent grades are currently being made in the open-hearth and electric furnace, and it is planned to add requirements in the hot-rolled and cold-rolled bar specifications, A 107 and A 108. Work continues on the requirements for cold finish alloy steel bars.

Sheets.—In the subcommittee on sheet steels, requirements are being studied for cold-rolled commercial quality sheets. Various revisions are in course of approval in the sheet Specifications A 245, A 246, and A 303. When agreement is reached on methods of sampling, requirements for flange and firebox quality sheets published for information are to be recommended as tentative. Another item reviewed at the meeting was the question of requirements for cold-rolled drawing quality sheets.

High Temperature Service.—In the work on valves, flanges, and fittings for high temperature service, parallel action on conservation of molybdenum with Subcommittee IX was approved. Work is to proceed on a new specification for welded austenitic pipe paralleling the fusion welded pipe requirements for both alloy and carbon grades in Specification A 155. Studies are continuing on standard

requirements for centrifugally cast pipe for use at elevated temperature, particularly in the power industry.

Bolting.—In Specification A 307 for carbon steel machine bolts and nuts and tap bolts, clarification as to the types of nuts to be used under the specification is being effected in order that the American Petroleum Institute may cross reference A 307 in their specifications. In the new alloy steel bolt specification it will be made clear that the material is intended for use at normal atmospheric temperatures where high strength is required. For other applications at elevated or subnormal temperatures, Specifications A 193 or A 320 should be used.

Honorary Members:

Two long-time members of the committee who have rendered notable service in its behalf were elected to honorary membership. Robert W. Steigerwalt, now consultant to the U. S. Steel Co., where for many years he was Metallurgical Engineer concerned with forging steel, tires, and related materials; and J. Roy Tanner of the firm, Tanner and Arnold, who was very active in the work involving pipe and tubing, and materials for high temperature service, were so honored.

Electrical Heating, Resistance, and Related Alloys Committee Meets in Philadelphia

COMMITTEE B-4 on Electrical Heating, Resistance, and Related Alloys held its Winter meeting January 31 and February 1, 1952, at the Benjamin Franklin Hotel in Philadelphia.

Strong evidence of the activity of Committee B-4 is apparent from the number of recommendations which will be submitted to letter ballot of the committee between now and June so that Society action can be taken at that time. Included in these recommendations is the approval as tentative of the Proposed Method of Test for Relative Thermionic Emissive Properties of Materials used in Electron Tubes which was published for information as an appendix to the 1950 B-4 Report. Work has been completed on a tentative specification for fine chromium-copper wire. A number of methods for analysis of electronic nickel have been completed. These will be sent to Committee E-3 for review and subsequently balloted on by the committee. Committee B-4 also voted to submit to letter ballot of the committee, revisions in B 106 – 51 T (testing thermostat metals), B 191 – 50 T (equivalent yield stress of thermostat metals), and B 223 – 51 T (modulus of elasticity of thermostat metals).

In addition to the above actions progress is being made on a standard triode specification, measurement of sublimation by a resistance method, and a comparison of three methods for determination of interface resistance.

It was agreed that it would be desirable to try to establish meeting dates at least a year in advance and accordingly it was decided that the meetings of Committee B-4 for the immediate future should be as follows:

June (early), 1952—Atlantic City
September or October, 1952—Pittsburgh or Washington
January or February, 1953—Philadelphia
June, 1953—Atlantic City (Annual Meeting)

New ASTM Committee on Mass Spectrometry

ACTION of the Board of Directors at their meeting on January 22 authorized the formation of a new ASTM Committee on Mass Spectrometry. The formal organization meeting of the committee will be held March 6 in Pittsburgh at which time it is expected the scope will be worked into final shape.

For some time within ASTM active consideration has been given to the desirability of organizing such a group to coordinate work on mass spectrometry. A number of outside groups interested in the subject had been formed and as the number increased so also did the awareness of the need for one national group to coordinate the work and provide for meetings of national scope. Accordingly, a conference was held at ASTM Headquarters early this year to consider this problem. At this conference it was agreed that the desired coordination of work and exchange of information could best be accomplished through a committee of ASTM rather than as a new separate society or as an affiliate of a national society other than ASTM.

Further information on committee personnel and scope will appear in the April BULLETIN.

G. G. Oberfell Awarded Honorary Membership in Committee D-2

ON MONDAY, December 10, 1951, at a special luncheon attended by most of the officers and others of the Phillips Petroleum Co. interested in ASTM activities, George G. Oberfell was presented with a certificate of Honorary Membership in ASTM Committee D-2 on Petroleum Products and Lubricants. Mr. Oberfell is the tenth member of Committee D-2 to receive this honor, which must be approved by the entire membership of the Committee, and is bestowed only upon those who are acknowledged to be outstanding leaders in their field.

Before his retirement in 1950, Oberfell was director, member of the executive committee, and vice-president of research and development for the Phillips Petroleum Co. Among other honors he has received are the distinguished service award of the Liquefied Petroleum Gas Association, and a certificate of appreciation from the Division of Refining of the American Petroluem Institute.

The award was presented by R. C. Alden, member of the Advisory Committee of ASTM Committee D-2 and chairman of the research planning board of Phillips' Research and Development Department. Standing by to congratulate Oberfell was K. S. Adams, chairman of the Board for Phillips.

Dr. Bonnet to Receive Smith Medal at Textile Committee Meeting

DR. Frederic Bonnet, pioneer in the development and utilization of rayon, will receive the Harold De Witt Smith Memorial Medal at the March meeting of ASTM Committee D-13 on Textile Materials.

The medal, a testimonial to the memory of the late Harold De Witt Smith, is awarded for outstanding accomplishment in the field of textile fiber science and utilization, including the development and promotion of knowledge of textile fibers and structures and methods for the evaluation of their properties.

Dr. Bonnet who is perhaps best known for his work in the field of rayon, was for many years Director, Standards Department, American Viscose Corp., and since his retirement in 1946 has been serving the company as Consultant and Technical Adviser to the President.

Left to right—G. C. Oberfell, R. C. Alden, and K. S. Adams

Committee D-23 on Cellulose and Cellulose Derivatives Formed

New Group to Work Closely with Others in the Field

CELLULOSE and cellulose derivatives have become an important group of materials reaching into the fields of activity of a number of existing ASTM committees, such as the committees on paint, paper, wood, plastics, electrical insulating materials, textiles, soaps, and other detergents. These committees have developed standards on cellulose in general but it has been a fringe activity. As a result of conferences among these many interests, including other technical organizations, it was recommended to the ASTM Board of Directors that a new committee be organized which would concentrate and bring together this type of standardization.

Committee D-23 on Cellulose and Cellulose Derivatives was accordingly organized, at the direction of the Board, late in 1951, at ASTM Headquarters. From the beginning it was evident that this committee would be working in a field in which much research had already been accomplished, not only by other ASTM committees but by such national organizations as American Chemical Society, Technical Association of the Pulp and Paper Industry, Institute of Paper Chemistry, and others. The need for avoiding duplication of effort was stressed and cognizance given to this fact in the scope, which reads as follows:

> "The definition of terms, and the study and formulation of test methods and specifications covering cellulose for chemical conversion and cellulose derivatives, these activities to be coordinated in cooperation with relevant committees in ASTM and outside organizations."

In addition to authorizing an Executive Subcommittee and a Subcommittee on Definitions and Nomenclature, four other subcommittees were agreed upon, covering methods for evaluating cellulose, organic esters, inorganic esters, and ethers. In order to establish the organization of each working subcommittee and to fill their memberships with those who are definitely interested in the particular field, a detailed questionnaire was compiled and distributed to all members on the initial list and to a number of other individuals who might be interested in participating. In order to maintain close correlation with other groups, official representation has been obtained from the several ASTM committees referred to above and from other national organizations.

Committee Personnel

The temporary officers and initial membership list are as follows:

Temporary Chairman: F. A. Simmonds, U. S. Forest Products Laboratory.
Temporary Secretary, W. W. Becker, Hercules Powder Co.

Name	*Representative*
American Chemical Society—Cellulose Division	J. L. McCarthy
American Enka Corp.	Charles H. Lindsley
American Viscose Corp.	Hale Cowling
Buckeye Cotton Oil Co.	L. N. Rogers
Celanese Corp. of America	Miss B. B. White
D-1 on Paint, Varnish, Lacquer, and Related Products	W. W. Becker
D-6 on Paper and Paper Products	R. M. Coleman
D-7 on Wood	L. J. Markwardt
D-9 on Electrical Insulating Materials	F. L. Stiegler
D-12 on Soaps and Other Detergents	B. A. Schroeder
D-13 on Textile Materials	C. M. Conrad A. G. Scroggie C. O. Werner Robert L. Burton
D-20 on Plastics	D. E. Northrop
E-2 on Emission Spectroscopy	
Dow Chemical Co.	A. T. Maasberg
Du Pont de Nemours & Company, Inc.	R. S. Apple Robert L. Burton A. G. Scroggie
Eastman Kodak Co.	L. B. Genung
Hercules Powder Co.	W. A. Kirklin
Industrial Rayon Corp.	Emil Kline
Institute of Paper Chemistry	B. L. Browning
Monsanto Chemical Co.	F. Faxon Ogden
Olin Industries, Inc. (Ecusta Paper Corp.)	R. M. Levy and M. O. Schur
F. H. Osborne, C. H. Dexter, and Sons, Inc.	
Pepperell Manufacturing Co.	G. K. Lake
Purex Corp., Ltd.	John J. Morrisroe
F. W. Smith, Wyandotte Chemicals Corp.	
Southern Research Institute	Edward Abrams
Technical Assn of the Pulp and Paper Industry	A. S. O'Brien
Tennessee Eastman Co.	J. A. Mitchell
USDA Northern Regional Research Laboratory	E. C. Lathrop
USDA Southern Regional Research Laboratory	Kyle Ward, Jr.
William K. Wilson, National Bureau of Standards	
Consulting Members	
Celon Company	Kenneth E. Glidden
N. Y. State College of Forestry	C. V. Holmberg
University of Delaware, Agricultural Experiment Station	G. L. Baker
Visking Corporation	M. Seidman and C. J. B. Thor

Committee D-12 on Soaps to Hold March Meeting in New York City

Several Technical Papers Scheduled

IN ADDITION to committee reports and discussions involving its research and standardization activities in the field of soaps and other detergents, ASTM Committee D-12 has arranged for several technical papers dealing with the fields of metal cleaning and testing of detergents and also a symposium on Statistical Methods for the Detergent Laboratory at its March 17 and 18 meetings at the Park-Sheraton Hotel in New York City. Those interested in the technical papers are invited to attend.

Papers tentatively scheduled for the meeting include the following:

Metal Cleaning Before Electroplating—H B. Linford, Columbia University

Metal Cleaning—William Stericker, Philadelphia Quartz Co.

Methods of Testing Detergents by Soil Cloth—J. A. Woodhead, Colgate-Palmolive-Peet Co.

Tentative papers in the "Symposium on Statistical Methods for the Detergent Laboratory" will be:

Tests of Significance—P. L. Schmidt, Westinghouse Electric Corp.

Comparison of Variability—L. Beck, Alexander Smith, Inc.

Statistical Treatment of Detergency Data—J. Sherman and R. Bernstein, Philadelphia Naval Shipyard

The Importance of Correlations in Detergents Testing—J. M. Lambert and E. J. Leshan, General Aniline and Film Corp.

The Design of Laboratory Control of Commercial Laundries—G. S. Freeman and M. I. Cohn, American Conditioning House, Inc.

These papers will be summarized and discussed by O. P. Beckwith, Alexander Smith, Inc., for ASTM Committee E-11 on Quality Control of Materials.

Among the subcommittees scheduled to meet is the reactivated group on Analysis of Synthetic Detergents. This Subcommittee, T-2, is concerned with infrared analyses of synthetic detergents and there is to be a discussion of developments in this field.

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column.

NOTE—*These "Personals" are arranged in order of alphabetical sequence of the names. Frequently two or more members may be referred to in the same note, in which case the first one named is used as a key letter. It is believed that this arrangement will facilitate reference to the news about members.*

Among the personnel affected by a series of executive appointments at **The Detroit Edison Co.** are two very active ASTM members—**Claire H. Fellows** and **Harvey A. Wagner.** Mr. Fellows has been promoted to Director, Engineering Laboratory and Research Department; and Mr. Wagner, formerly Chief Mechanical Engineer, is now also Assistant Chief Engineer, Engineering Department. These appointments were announced by President Walker L. Cisler, who at the same time noted three key appointments to lighten the load now carried by Paul W. Thompson, Vice-President in Charge of Engineering, who will retire in about a year. George A. Porter, former Chief Engineer of Power Plants, has been named Manager of Construction; Howard P. Seelye, former Chief Engineer of the Engineering Department, has been appointed Manager of Engineering; and William W. Williams, former Chief Engineer of Lines, has been made Manager of Operations.

In ASTM, Mr. Fellows is now serving his second term as a member of the ASTM Board of Directors where he heads the important Committee on Membership. He has been very active in the work of such technical committees as D-2 on Petroleum Products and Lubricants, D-9 on Electrical Insulating Materials, and D-19 on Industrial Water. He was the first Chairman of the Administrative Committee on District Activities, and is a Past-Chairman of the Detroit District.

Mr. Wagner has been especially active in the work of Committee A-1 on Steel where his widespread knowledge of materials utilized in power plants, particularly at elevated service, has been used constructively in the important work of Subcommittee XXII on Valves, Fittings, Pipings and Flanges for High-Temperature and Subatmospheric Temperatures. Mr. Wagner also is genuinely interested in ASTM membership promotion for the Detroit District.

Fred C. Bailey, formerly Research Engineer, Caterpillar Tractor Co., Peoria, Ill., is now Technical Secretary, National Research Council, National Academy of Sciences, Washington, D. C.

Joseph L. Barach heads the new Research Group, one of three major groups recently established within the Research and Development Department of Alexander Smith, Inc. In this capacity he will supervise all research activities dealing with products, fabrics, and processes. Mr. Barach represents his company on ASTM Committees D-13 on Textile Materials, and E-12 on Appearance.

Robert G. Betts, for many years Sales Engineer, W. & L. E. Gurley, Troy, N. Y., has been named Executive Vice-President and Treasurer.

Alfred L. Boegehold has been named Assistant to the General Manager, General Motors Research Laboratories, Detroit, Mich. He has been associated with the GM Laboratories since 1920. A Past-President of the American Society for Metals, and for a number of years an executive committee member of the Iron & Steel Institute of AIME, Mr. Boegehold is the author of a number of publications on such subjects as wear testing of cast iron, automotive engineering requirements for metals operating at high temperatures, endurance of gear steels, a hardenability test for carburizing steel, and heat treating for machinability. He has represented his company on ASTM Committee A-3 on Cast Iron since 1926, and also for a number of years has been a member of the Special Subcommittee on Hardenability of Committee A-1 on Steel.

K. R. Brown, formerly Director, Research and Development Dept. is now Vice-President, Atlas Powder Co., Wilmington, Del.

Miles N. Clair, President of Thompson & Lichtner Co., Inc., Consulting Engineers, Brookline, Mass., recently was paid high tribute by the ASCE student chapter of Northeastern University, when this group made him its first honorary member. According to Professor E. L. Spencer of the University, Mr. Clair has given unstintingly of his time and energy for the past decade in serving as senior contact member with Northeastern students. He has likewise given generously of his time and efforts in many phases of ASTM work, having been one of the organizers of the New England District Council, and serving successively as its Secretary, Vice-Chairman, and Chairman. He is presently a member of the Administrative Committee on District Activities, and also serves on a number of ASTM technical committees.

Ernest W. Dean, Consulting Chemist and Vice-Chairman of the Products Committee, Standard Oil Development Co., was presented with a thirty-year service award by his company, presentation being made before a group of his friends and associates by Eger V. Murphree, President, in the New York offices. Dr. Dean joined the Standard Oil Co. (N. J.) in 1922 as Director of their Standard Inspection Laboratory. At that time he was nationally known for his knowledge of the procedures and instruments for the testing of petroleum products. In 1950, he was made Vice-Chairman of the Products Committee. A member of many technical and scientific societies, Dr. Dean has represented his company for over 25 years on ASTM Committee D-2 on Petroleum Products and Lubricants. He also represents the sustaining membership of Standard Oil Development in the Society, and serves on other technical committees.

George A. Farrah, until recently Technical Director, National Container Corp., Long Island City, N. Y., has been appointed Assistant to the Vice-President. He will be in charge of the Wisconsin-Minnesota area, with headquarters at the company's converting plant in Tomahawk, Wis.

N. Howell Furman, Professor of Chemistry, Frick Chemical Lab., Princeton University, has been appointed to the advisory board of *Analytical Chemistry* for a four-year term. A member of the American Chemical Society since 1915, his most recent notable achievement as President of ACS in its Diamond Jubilee year culminated years of participation in that society's activities. Affiliated with ASTM for many years, Professor Furman has served on a number of the subgroups of Committee E-3 on Chemical Analysis of Metals.

Walter J. Hamburger, Director of the Fabric Research Laboratories, Boston, Mass., was granted an honorary degree by Lowell Textile Institute at the Institute's Open House program in December, in recognition of outstanding contributions in textile research.

George W. Jernstedt has been appointed Manager of Engineering for the Special Products Development Division of Westinghouse Electric Corp., Pittsburgh, Pa. Associated with Westinghouse since 1936, Mr. Jernstedt has been for some time in charge of Electroplating Projects, in which capacity he will continue in addition to his new appointment.

Alfred S. King, formerly Process Engineer, Houdry Process Corp., Philadelphia, Pa., is now Supervisor, Service and Sales, Wilson Meyer Co., San Francisco, Calif.

Stewart S. Kurtz, Jr., Manager, Experimental Div., Sun Oil Co., Norwood, Pa., has been elected to a four-year term on the advisory board of *Analytical Chemistry*. Active in the American Chemical Society for many years, also in other professional and technical societies, Dr. Kurtz has rendered important service in a number of ASTM technical groups, especially in Committee D-2 on Petroleum Products and Lubricants where he heads the Research Division on Hydrocarbon Analysis, and the Coordinating Division on Nomenclature.

Harry Majors, Jr., Director, Engineering Experiment Station, University of Alabama, has been granted a two-year leave of absence from the University to become associated with the California Research and Development Corp., Livermore, Calif., as a Senior Engineer.

Robert F. Mehl, Director, Metals Research Laboratory, and Head of the Metallurgical Engineering Dept., Carnegie Institute of Technology, Pittsburgh,

Pa., spent January in Brazil as head of a commission of the Technical Cooperative Administration (President Truman's Point Four Program) under the auspices of the Department of State.

Floyd L. Miller succeeds Robert C. Gunness as Vice-Chairman of the Research and Development Board of the Defense Department in Washington, D. C. Dr. Miller has been Director of the Research Division of the Esso Standard Oil Laboratories since 1947.

J. Strother Miller, previously with the Barber Asphalt Corp., but since retirement with Miller-Warden Associates, has changed his address from P. O. Box 415, Rahway, N. J., to 391 Elm Ave., Rahway. He continues his interest as consultant in asphalt technology and related engineering problems.

Cleveland F. Nixon, formerly Director of Process Development for the Ternstedt Division of General Motors Corp., Detroit, Mich., has been appointed Head of the GM Research Electro-Chemistry Department.

M. D. Olver, for many years Chemical Engineer with the Allentown Portland Cement Co., Conshohocken, Pa., retired as of January 1. He is succeeded in the company by **W. P. Heck** who also will take over company representation in the Society.

George R. Parkin, until recently Chief Industrial Engineer, Arms Textile Manufacturing Co., Manchester, N. H., is now Resident Manager, Sheble & Wood Yarn Corp., Salamanca, N. Y.

Erling F. Rosholdt has accepted a position as Chemical Engineer, Atlantic Research Corp., Alexandria, Va. He was formerly with the Hamilton Standard Propeller Div., United Aircraft Corp., East Hartford, Conn.

Samuel R. Scholes, Professor of Glass Technology, New York State College of Ceramics, Alfred University, Alfred, N. Y., will be presented the Albert Victor Bleininger Award, highest award conferred (annually) in the field of ceramics, at the March meeting of the Pittsburgh Section of the American Ceramic Society. A member of many scientific and technical societies, and the author of many papers, Dr. Scholes also is author and editor of three books: "Modern Glass Practice" (1935), "Glass Tank Furnaces" (translated from French) (1938), and "Handbook of the Glass Industry" (1941). Affiliated with ASTM for many years, Dr. Scholes has participated in the activities of Committee C-14 on Glass and Glass Products and many of its subcommittees, serving as Secretary of the main group 1944–1948.

Norman H. Spear, formerly with the John B. Pierce Foundation, New Haven, Conn., is now Research Physicist, Colt's Manufacturing Co., Hartford, Conn.

Lee M. Springer, until recently with Utility Industries, Los Angeles, has accepted a position as Mechanical Engineer, B. & M. Engineering Co., Glendale, Calif.

Haakon Styri has retired as Director of Research, SKF Industries, Inc., Philadelphia. He will continue with the company in a consulting capacity. Dr. Styri represented his company in ASTM for many years, serving on Committees B-5 on Copper and Copper Alloys, and E-4 on Metallography, also as a member of the Special Subcommittee on Bearing Steels of Committee A-1. He will continue his ASTM affiliation through individual membership.

C. G. Stupp is now Technical Director, The Barrett Division, Allied Chemical & Dye Corp., New York City, succeeding **S. P. Miller** who recently retired after many years of service.

James R. Thompson, Manager of the Metallurgical Department of American Steel and Wire Co., Cleveland, Ohio, retired December 1, after a half-century of service. Joining the company in 1901 as a chemist at the Newburgh Steel Works, he served in many capacities before being named manager of the metallurgical department in 1942. He had represented his company for many years in ASTM, and on Committees A-1 on Steel and B-1 on Wires for Electrical Conductors. **W. R. Miller** succeeds Mr. Thompson in the company, and as the company's representative in the Society.

John R. Townsend, Past-President of the Society, and currently Chairman of the Committee on Arrangements for the Fiftieth Anniversary Meeting, has been appointed Director of Materials Applications Engineering of his company, Bell Telephone Laboratories, Inc., Murray Hill, N. J. His many friends in the Society will be pleased to know of this expansion of his responsibilities. Prior to his position as Materials Engineer he was Materials Standards Engineer. Reference is made in another short article in this BULLETIN to Mr. Townsend's appointment also as Consultant on Conservation of Materials, Office of Defense Mobilization. In this capacity he is to report directly to Charles E. Wilson, Director of the ODM.

Kent R. Van Horn, one of the nation's leading research metallurgists and an authority on industrial X-ray, has been named Director of Research, Aluminum Company of America, New Kensington, Pa., succeeding Dr. Francis C. Frary, who has retired. Dr. Frary for many years represented the company's sustaining membership in ASTM. Joining ALCOA in 1929 as Research Metallurgist, Cleveland Division of the Aluminum Research Laboratories, Dr. Van Horn was placed a year later in charge of the X-ray Department, and in 1944 became Assistant Manager of the Cleveland Research Division, being advanced to Division Chief in 1945, and Assistant Director of Research for the Cleveland branch in 1949. A member of many technical and research societies, he served in 1944 as president of the American Society for Metals. Dr. Van Horn also is a past-president of the American Society for Non-Destructive Testing. He has written a number of articles in technical publications and is co-author of a textbook, "Praetical Metallurgy," with Dr. George Sachs. Another Van Horn book, "Alloys of Iron and Aluminum," is scheduled for publication this year. In ASTM he has served for a number of years as representative of ALCOA on Committees E-7 on Non-Destructive Testing, and E-8 on Nomenclature and Definitions.

Lincoln T. Work, Consulting Engineer, New York City, has been appointed to the advisory board of *Industrial and Engineering Chemistry* and *Chemical and Engineering News* for a term of four years. Dr. Work was 1950 Chairman of the ACS Division of *Industrial and Engineering Chemistry*, and is now President-elect of the American Institute of Chemists. Affiliated with ASTM since 1924, he has been active in a number of the technical committees of the Society, also in the New York District Council. Currently Vice-Chairman of the Committee on Arrangements for the ASTM's Fiftieth Anniversary Meeting, he also heads the Subcommittee on Laboratory Visits. Among other technical problems in which he has had a leading part is fineness testing—he heads the "Sub-Sieve Testing" group of Committee E-1 on Methods of Testing.

NEW MEMBERS...

The following 105 members were elected from January 1 to January 29, 1952, making the total membership 7093. . . . Welcome to ASTM

Note—Names are arranged alphabetically—company members first then individuals

Chicago District

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NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses.

Catalogs and Literature

Specimen Polishing with Diamond Compound—A four-page folder describes the advantages of diamond abrasives for polishing metallurgical specimens. Diamet-Hyprez is offered in three different particle sizes, all in 5-gram and 18-gram gun applicators.

Buehler Ltd., 165 W. Wacker Dr., Chicago 1, Ill.

Metallographic Polishing—All of the Buehler two-speed polishers are described in this booklet. Units are available for flush or table mounting and in single, double, or triple unit tables.

Buehler Ltd., 165 W. Wacker Dr., Chicago 1, Ill.

Electroanalysis of Copper and Lead—A new 20-page manual outlining methods for the analysis of copper and lead by electroanalysis has been prepared by Eberbach Corp. for distribution with its Electroanalysis apparatus. The methods and extensive bibliography are a product of research at Battelle Memorial Institute. The booklet is expected to be helpful to all laboratories performing analyses of this kind.

Eberbach Corp., Ann Arbor, Mich.

Unit for Colorimetry, Fluorometry and Nephelometry—A 16-page booklet, "The Nefluoro-Photometer," just published by the Fisher Scientific Co., explains the theory behind three important methods of analysis: colorimetry, fluorometry and nephelometry; and the operation of a new precision instrument combining all three of these techniques in one simple electronic-optical system. The three-in-one instrument, the "Nefluoro-Photometer," is said to give rapid (60 second) readings for a great variety of organic, inorganic, synthetic, and biological materials, from acetone to zinc and including vitamins A, B_1, B_2, C, E, and K.

Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Washability and Abrasion Tester—A new four-page brochure describes the Gardner "Washability and Abrasion Testing Machine" for paints, lacquers, linoleum, waxes, products. The procedures for both washability and abrasion tests using the apparatus are extensively described. Also described is the new "abrasion boat" attachment permitting the adaptation of the machine to wet or dry abrasion testing.

Gardner Laboratory, Inc., Bethesda 14, Md.

General Laboratory Equipment—A new four-page brochure published by the Emil Greiner Co. describes new instruments available from them. The instruments include a one-pan, one beam weight balance for rapid laboratory weighing, an electric stop watch embodying many unusual features, and a laboratory torch using containers of self-pressurizing nontoxic hydrocarbon fuel. Of particular interest to ASTM members will be the short description of the new "McLeod Gauge"—suitable, according to the manufacturer, for ASTM Tentative Test for Reduced Pressure Distillation of Petroleum Products (D 1160 – 51 T).

The Emil Greiner Co., 20–26 N. Moore St., New York 13, N. Y.

Universal Testing Machines—A new 32-page catalog on hydraulic universal testing machines has just been issued by Riehle Testing Machines Div. of American Machine and Metals, Inc. Handsomely printed in color, this catalog contains illustrations, specifications, and operating details on machines with capacities up through 400,000 lb. Four different models of hydraulic universal testing machines are described, composed of various combinations of loading units and indicating units. There is also a section on accessories and instruments.

Catalog RU-7-52, Riehle Testing Machines Div. of American Machine and Metals, Inc., East Moline, Ill.

Instrument Notes

Monochromatic Light—A recently introduced monochromatic light is designed specifically for making light wave measurements in the shop or laboratory. Used in conjunction with optical flats, the new light, with its large, bright working field, avoids the necessity of exact placement of the work, and makes inspection easy and fast. Because it emits light of a single wave length, the interference bands appear clear and sharp, and can be seen on a relatively dull surface or through an appreciable air gap. Each interference band seen under the light means a vertical height change of 11.6 millionths of an inch, and, it is stated, can easily be interpreted to determine surface deviation from flatness, as well as other measurements, to within one-millionth of an inch. Weighing 17 lb it comes equipped for operation on 110–120 v, 60 cycle ac.

Acme Scientific Co., 1457 W. Randolph St., Chicago 7, Ill.

Universal Testing Machine—An improved, low-cost universal testing machine of 120,000 lb capacity is announced. The new Model 120-H, like the 12-H announced earlier in 1951, and the 60-H, has many of the features of larger Baldwin testing machines. One is that the hydraulic loading unit is separate from the indicating and control unit, which isolates recoil from breaking test specimens and permits adjusting maximum or lazy hands with minimum drag. Rigidity is provided in a two-column design with 15 in. of clear lateral space between columns. This gives easy access to test specimens and simplifies observations. Load (either in tension or compression) is applied upward by an integrated piston and elevating cage consisting of the table, two uprights and upper gripping head, all of which have a 6-in. power stroke. Loading speed can be varied infinitely between 0 and 2 in. per minute. Two ranges, 0–120,000 and 0–30,000 lb, are available at small additional cost. Three ranges can be provided when required.

Baldwin-Lima-Hamilton Corp., Paschall Station P. O., Philadelphia 42, Pa.

Carbon Train—A new unit package carbon train for improved gravimetric determinations of carbons-by-combustion has been introduced by the Burrell Corp.

(*Continued on page 53*)

Rapid Method for Estimating Cement Content of Soil-Cement and Blended Cements

By J. L. Gilliland[1] and H. M. Hunter[1]

ACID-SOLUBLE calcium provides the basis on which the cement content of soil-cement mixtures is now determined.[2] It is also being used to estimate the cement content of hardened concrete.[3] Similarly, it provides a method for the cement content of blended (portland-pozzolan) cements. The calcium may be determined either gravimetrically or volumetrically, following precipitation as calcium oxalate.

The method proposed in this paper is based on the combined content of acid-soluble calcium and magnesium. They are determined by a direct titration which does not require their prior precipitation. As a result, the proposed method permits a considerable saving of time over the procedures now in use.

Titration of Calcium and Magnesium

A vast majority of the laboratories analyzing water for hardness have adopted the versenate titration method[4] for the determination of calcium and magnesium. Versenate is the name given to the salts of ethylenediamine tetra-acetic acid, which have the ability to form soluble complexes with heavy metal ions. The titration is conducted in the presence of an indicator, Eriochrome black T, which exhibits a red color in the presence of calcium and magnesium ions and a blue color when these ions have been completely converted into the complexes. The titration must be performed at a pH of approximately 10. The same reagent is used in water analysis to determine calcium separately by means of another indicator, ammonium purpurate. However, this indicator did not give a satisfactory end point in the present work, possibly due to the high ratio of calcium to magnesium, or to the presence of interfering salts. Since much of the described work is based on a comparison with control titrations of the components, it makes little difference whether combined calcium and magnesium, or calcium alone is titrated.

Preparation of Reagents:

Buffer solution.—Dissolve 67.5 g of NH_4Cl in 570 ml of concentrated NH_4OH, and dilute to 1 liter.

Indicator.—Mix 0.5 g of analytical reagent grade Eriochrome black T with 4.5 g of hydroxylamine hydrochloride. Dissolve 0.5 g of this mixture in 100 ml of methyl alcohol.

Sulfide solution.—Dissolve 10 g of NaOH in 100 ml of water. Dissolve 5 g of Na_2S in 100 ml of water. Cool the two solutions, mix them together, and dilute to 1 liter.

Reagent disodium dihydrogen ethylenediamine tetra-acetate.—Dissolve 4 g of analytical reagent grade disodium dihydrogen ethylenediamine tetra-acetate and 0.1 g of $MgCl_2 \cdot 6H_2O$ in 1 liter of distilled water. The exact strength of this reagent need not be known, since the calculations are on a relative basis.

Cement Content of Soil-Cements

ASTM Method D 806 – 47[2] requires that the acid-soluble materials in the samples be dissolved, the iron and aluminum oxides double precipitated, and removed by filtration. The calcium is then precipitated as the oxalate, filtered, dissolved, and titrated with $KMnO_4$. These steps are performed on samples of the soil, cement, and soil-cement mixture. From the relative amounts of calcium in the components and in the mixture, the cement content of the mixture is calculated.

In this proposed method the following procedure is suggested:

Make the initial solution and separation of the acid-soluble portion as described in Sections 4 through 5(*c*) of Method D 806. Dilute the filtrate to 250 ml with cold water and agitate the flask to thoroughly mix the contents. Pipet a 50-ml aliquot into a 250-ml volumetric flask. Neutralize with NH_4OH, using litmus paper as an indicator. Dilute to 250 ml, and agitate thoroughly. Pipet 50 ml of the supernatant liquid into a 250-ml wide-mouth Erlenmeyer flask, add 1.0 ml of the buffer solution, 2 to 4 drops of the sulfide solution, 4 drops of indicator, and titrate with the reagent solution. The calculations are performed as described in Section 6(*b*) of Method D 806.

The results obtained by both methods on a series of soil-cements are shown in Table I. Portland cement, fine to

TABLE I.—COMPARISON OF RESULTS BY PERMANGANATE AND VERSENATE METHODS.

Lab. Number	Material	Titration, ml		Cement, Dry Basis, per cent	
		$KMnO_4$	Versenate	D 806 – 47	Versenate Method
A-1128	Cement 1	46.80	23.00	...	...
A-1129	Soil A	4.35	2.33	...	...
A-1130	Soil B	4.60	2.78	...	...
A-1131	Cement 1 + soil A (hydrated)	25.80	12.70	9.71	9.58
A-1132	Cement 1 + soil B (hydrated)	20.00	10.38	6.98	7.04
A-1133	Cement 2	47.60	23.32	...	...
A-1134	Soil C	4.70	2.57	...	...
A-1135	Soil D	3.23	2.00	...	...
A-1136	Cement 2 + soil C, dry mix	28.15	14.30	10.05	10.29
A-1137	Cement 2 + soil D, dry mix	22.65	11.50	8.27	8.29
A-1138	Cement 3	46.90	23.10	...	...
A-1139	Soil E	4.70	2.57	...	...
A-1140	Cement 3 + soil E, dry mix	25.51	12.79	9.06	9.05
A-1141	Cement 4	47.20	23.31	...	...
A-1142	Soil F	5.10	3.03	...	...
A-1143	Soil G	1.43	1.02	...	...
A-1144	Cement 4 + soil F, dry mix	22.90	11.48	7.71	7.44
A-1145	Cement 4 + soil G, dry mix	21.95	11.00	8.75	8.64
A-1146	Cement 5	47.65	23.00	...	...
A-1147	Soil H	5.32	3.00	...	...
A-1148	Soil J	2.45	1.48	...	...
A-1149	Cement 5 + soil H, dry mix	25.70	12.92	8.75	8.86
A-1150	Cement 5 + soil J, dry mix	21.05	10.56	7.89	8.00
A-1151	Cement 6	46.80	22.49	...	...
A-1152	Soil K	4.62	2.41	...	...
A-1153	Soil L	3.28	1.79	...	...
A-1154	Cement 6 + soil K, dry mix	27.20	13.40	9.84	9.99
A-1155	Cement 6 + soil L, dry mix	20.90	10.43	7.64	7.81
A-1156	Cement 7	46.23	22.62	...	...
A-1157	Soil M	4.37	2.42	...	...
A-1158	Cement 7 + soil M (hydrated)	56.31	28.08	23.82	24.11

NOTE.—Values for hydrated samples corrected to dry basis according to Note 2, Section 6(*b*) of Method D 806.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Bureau of Reclamation, Denver, Colo.

[2] ASTM Standard Method of Test for Cement Content of Soil-Cement Mixtures (D 806 – 47), 1949 Book of ASTM Standards, Part 3, p. 1194.

[3] S. R. Bowden and E. H. Green, "The Analysis of Concretes," National Building Studies, *Technical Paper No. 8*, Dept. of Scientific and Industrial Res., London, July, 1950.

[4] J. D. Betz and C. A. Noll, "Total-hardness Determination by Direct Colorimetric Titration," *Journal*, Am. Water Works Assn., Vol. 42, pp. 49–56 (1950).

medium silty sand from Eastern Colorado and mixtures of the cement and sand were used in the tests. From these values it appears that the results obtained by the versenate method compare favorably with those by the present standard method. It permits a considerable saving in time inasmuch as two precipitations and three filtrations are eliminated. After the samples have been dried and ground, the versenate method requires approximately one-half the time required by the permanganate method.

Cement Content of Fly Ash-Cement Blends

The increasing use of portland-pozzolan cements has emphasized the necessity for reliable methods that can be used to determine or control the relative proportions of cement and pozzolan in the blends. The ideal method is to find a component that is a major constituent of the one material and is absent or only a minor constituent in the other. Or, the behavior to some empirical test can be used, if one material responds and the other does not. For example, if the pozzolan is only slightly soluble under the conditions of the insoluble residue test for portlant cement,[5] the amount of insoluble material may be used to determine the amount of pozzolan in a blend. McCoy[6] has used the ability of slag to reduce potassium permanganate solutions as the basis for determining the slag content of portland blast-furnace slag cements.

The amount of insoluble material in fly ash varies considerably among different samples. Four fly-ash samples examined in this laboratory gave insoluble residue values of 75 to 84 per cent. It seems probable that a reasonably satisfactory determination of the cement content of a portland fly-ash cement could be accomplished in this manner where a sample of the fly-ash component is available. However, the determination of insoluble residue is a rather lengthy process and considerably more difficult than the test described in this paper.

A series of laboratory prepared fly-ash cement blends prepared from Chicago fly ash and portland cement was used to check the accuracy of the proposed methods. Samples of the cements, fly ash, and blends were tested, using the following procedure:

Disperse 1.000 g of the sample in 15 to 20 ml of water, then add 5 ml of concentrated HCl. Stir thoroughly, dilute to about 50 ml, and digest on the steam bath for 15 min. Filter through a Whatman No. 40, or equivalent paper, catching the filtrate in a 1-liter volumetric flask. Wash the paper thoroughly. Add a small piece of litmus paper to the filtrate, adjust the pH to just alkaline with NH_4OH, and dilute to volume. Mix the contents thoroughly, then allow the precipitate to settle. Pipet 25 ml of the supernatant liquid into a 250-ml wide-mouth Erlenmeyer flask. Dilute to about 50 ml, add 1.0 ml of buffer solution, 2 to 4 drops of sulfide solution, 4 drops of indicator, and titrate with the standard reagent solution.

The amount of cement in the blend is calculated as follows:

$$\text{Per cent cement} = \frac{\text{Titration of blend} - \text{titration of fly ash}}{\text{Titration of cement} - \text{titration of fly ash}} \times 100$$

Results of this series are shown in Table II. They indicate that the amount of cement in a blend can be estimated within 1 per cent, if samples of the fly ash and cement components are available to form a basis for the calculations. In the absence of these components, possibilities of large errors exist.

TABLE II.—DETERMINATION OF CEMENT IN CEMENT - FLY ASH BLENDS BY VERSENATE TITRATION.

Cement	Fly Ash	Blend	Versenate Titration, ml			Cement, per cent by weight		Deviation
			1	2	Average	As Blended	Determined (Avg.)	
No. 9939.	...	...	28.87	28.82	28.85	...	...	...
	No. A-464	...	2.82	2.82	2.82	...	...	...
		No. 1	24.80	24.78	24.79	85.04	84.40	−0.64
		2	23.62	23.62	23.62	80.91	79.91	−1.00
		3	22.58	22.62	22.60	75.99	75.99	0.00
		4	21.22	21.21	21.22	70.62	70.69	+0.06
No. 9940.	...	...	28.58	28.53	28.56	...	...	...
	No. A-464	...	2.82	2.82	2.82	...	...	...
		No. 1	24.45	24.46	24.46	84.89	84.07	−0.82
		2	23.37	23.42	23.40	80.78	79.95	−0.83
		3	22.33	22.33	22.33	75.87	75.80	−0.07
		4	20.98	20.92	20.95	70.52	70.44	−0.08
No. A-112	...	...	28.21	28.18	28.20	...	...	...
	No. A-464	...	2.82	2.82	2.82	...	...	...
		No. 1	24.29	24.25	24.27	84.60	84.52	−0.08
		2	23.35	23.36	23.36	80.52	80.93	+0.41
		3	21.97	22.06	22.02	75.64	75.65	+0.01
		4	20.75	20.79	20.77	70.32	70.72	+0.40
No. A-215	...	...	28.38	28.50	28.44	...	...	...
	No. A-464	...	2.82	2.82	2.82	...	...	...
		No. 1	24.63	24.68	24.66	84.46	85.25	+0.79
		2	23.65	23.68	23.67	80.39	81.38	+0.99
		3	22.41	22.33	22.37	75.53	76.31	+0.78
		4	21.03	21.08	21.06	70.22	71.19	+0.97

Other Uses

This same technique would appear to be applicable to other determinations in the field of cement mixtures and concrete. For example, it may have application in the test for the cement content of hardened concrete. Obviously, it could not be used if the aggregate used in the manufacture of the concrete contained significant amounts of calcareous material.

Summary

Titration of acid-soluble calcium and magnesium provides a rapid method of determining the cement content of soil-cement mixtures and of blended cements. When samples of the individual constituents are available, the accuracy compares favorably with that obtained by the slower methods. The titrating agent, versenate, is a relatively new chemical, introduced for use in water analyses.

Acknowledgment:

The laboratory work on soil-cement was performed by Mr. T. R. Bartley. Mr. R. N. Thomson conducted the studies on blended cements.

[5] Methods of Chemical Analysis of Portland Cement (C 114 – 47), 1949 Book of ASTM Standards, Part 3, p. 38.

[6] W. J. McCoy, "Rapid Control Method for the Determination of Slag in Portland-Blast Furnace Slag Cement," *Rock Products*, October, 1947, pp. 106–107.

Objective Test Methods for Paint Brushes

By M. J. Snyder,[1] E. R. Hunt,[1] and J. W. Clegg[1]

SYNOPSIS

This paper describes equipment and methods developed for testing paint brushes objectively. The tests were conducted on 3- and 4-in. brushes to determine the amounts of paint picked up and deposited by the brushes, numerical measures of the quality of the paint films laid down, measurement of brush stiffnesses, and coefficients of friction between brushes and surfaces to be painted.

Subjective tests on the same brushes showed that these procedures were reliable means of distinguishing between good, fair, and poor brushes.

APPROXIMATELY two and one-half years ago, E. I. du Pont de Nemours and Co., Inc., asked Battelle Memorial Institute to undertake work to improve nylon paint brushes. It was essential to this improvement study that objective tests be developed to evaluate brush changes accurately. Prior to this time, paint brushes were tested subjectively, and the results were usually vague and indeterminate.

The purpose of this paper, therefore, is to present details of the test methods developed for numerically rating paint brushes on the basis of various brush characteristics. These tests measured the ability of a brush to hold and deposit paint, the amount of work required to lay down a satisfactory film of paint with a brush, brush stiffness, how a brush snapped back after being bent, and the friction between the brush and the painting surface.

PAINTING MACHINE

The most important factors to be determined for a brush were how much paint it would pick up and paint out, and how well it spread paint. A machine was constructed for measuring these brush characteristics. This machine (see Fig. 1) was a mechanical painter that painted with every brush in the same manner on a vertical surface. Figures 2 and 3 are schematic diagrams showing the important dimensions of this apparatus.

Essentially, it consisted of an arm which held a brush and moved it back and forth over a paper surface. The ends of the surface were curved away from the brush to allow the brush to ride free at the end of each stroke. The brush was held at an angle of 10 deg from the perpendicular to the painting surface during painting. Although the length of stroke was about 36 in., only 24 in. of flat surface were available for the brush to paint on. A $\frac{1}{4}$-hp motor operated the mechanism and was geared down to move the brush at about 1.6 ft per sec. This machine was designed primarily to test 3- and 4-in. paint brushes. For smaller brushes, the length of stroke and the brush holder would have to be modified.

Testing Procedure for Painting Machine:

Prior to being tested on the machine, each brush was soaked in turpentine for at least 24 hr, blown dry, weighed, painted out by hand, then re-weighed. It was important that the hand-painting operation be continued until the brush attained an equilibrium painting condition. This condition was reached after about five repeated dips and paint-outs and could be detected with some experience. After painting out by hand, the brush was clamped in a brush holder to give a horizontal displacement of about $1\frac{1}{2}$ in. This displacement is defined as the distance that the bristles would extend beyond the painting surface if they were not bent by that surface. This particular displacement ($1\frac{1}{2}$ in.) applied to 3- and 4-in. brushes having a bristle length out from the ferrule of about $4\frac{1}{8}$ in. For brushes in which the length of bristle was appreciably different from $4\frac{1}{8}$ in., the displacement was adjusted proportionally to result in maximum bending of the brush without painting on its heel.

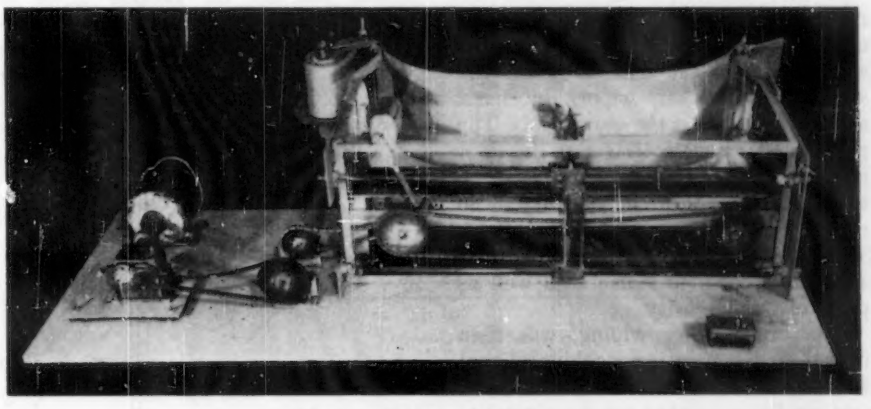

Fig. 1.—Painting Machine.

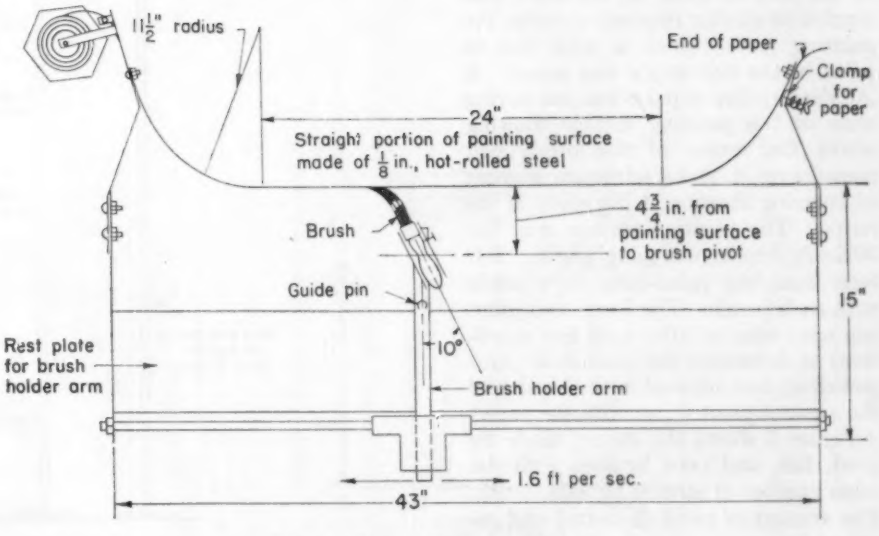

Fig. 2.—Plan of Painting Machine.

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[1] Battelle Memorial Institute, Columbus, Ohio.

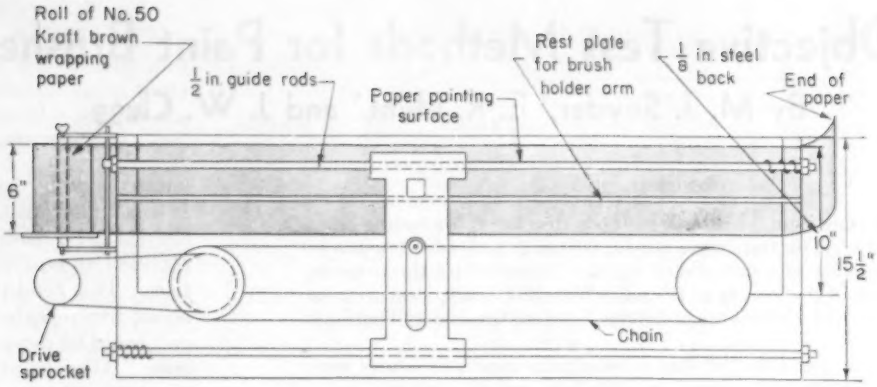

Fig. 3.—Elevation of Painting Machine.

After being clamped in the holder, the brush was dipped in paint to a depth of 2½ in., or about five-eighths of the bristle length, for a period of 30 sec and wiped on one side across a suspended wire (see Fig. 4). This exceptionally long period of dip was used in order to allow each brush to pick up its maximum load of paint. In wiping, the brush was held in a vertical position and pulled in an upward direction across the wire at an angle of 35 deg from the vertical. The wire was adjusted to strike the brush at the paint line at the beginning of the wipe. The brush was pulled steadily across the wire at about the same rate as when wiping by hand against the edge of the paint can. The paint used in these tests was du Pont interior flat wall paint adjusted with turpentine to a Stormer viscosity of 50 revolutions in 60 sec with a 50-g weight. The use of higher viscosity paint did not show differences in brushes so well as paint of this viscosity.

The brush, after wiping, was then placed on the painting machine so that the first stroke was made by the wiped side, and was painted out for a total of 60 strokes with a fresh surface supplied at the end of each 20 strokes. The number of strokes required to cover the painting surface with a solid film of paint in the first stripe was noted. A satisfactory film of paint was one having none of the painting surface showing where the center of the brush had passed over it, and a minimum amount of fingering showing at the edges of the stripe. The painting surface was No. 50Kraft, brown wrapping paper. Fifteen complete paint-outs were made with each brush. The brush and paint can were weighed after each five repetitions to determine the amount of paint picked up and retained in the brush and the amount painted out onto the paper.

Figure 5 shows the stripes made by good, fair, and poor brushes with the same number of strokes by each brush. The amount of paint deposited and retained by various brushes is given in Fig. 6. If the average paint-outs of any of the three groups of five tests differed from the average of all 15 tests by more than ±2.5 g, those results were discarded and an additional group of five tests was conducted. Then their average was used in computing a new average paint-out of the brush. Variations greater than ±2.5 g usually were caused by giving insufficient time to the preliminary hand painting.

The results of field tests by professional painters on various types of brushes tested with the painting machine showed that this was a reliable method of testing paint brushes for paint capacity and ability to spread paint.

Measurement of "Feel" Factors

In addition to measuring paint capacity and spreading ability of brushes, it was necessary to gain information concerning the factors that contributed to the "feel" of a paint brush. These factors appeared to be brush stiffness, friction between the brush and the painting surface, and the snapback of a brush after being bent as in painting. Tests were devised for measuring these several contributions to "feel."

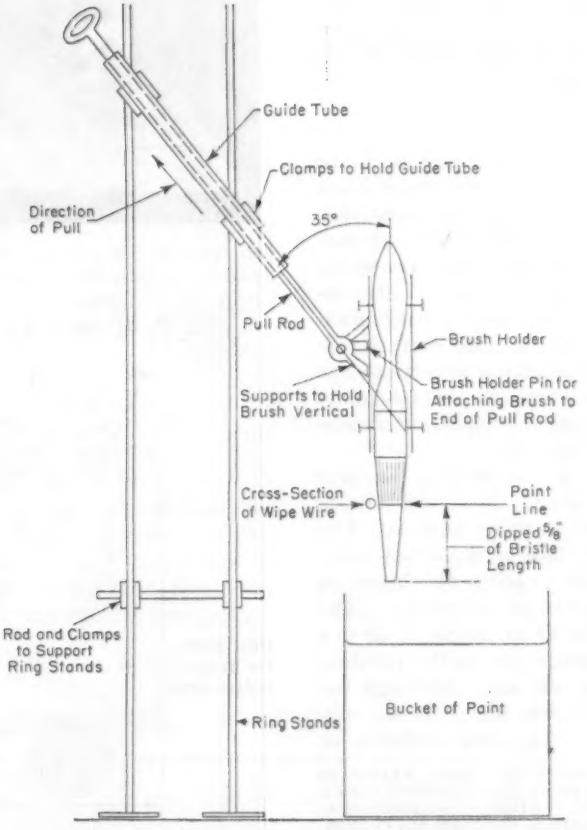

Fig. 4.—Paint Brush Wipe Mechanism.

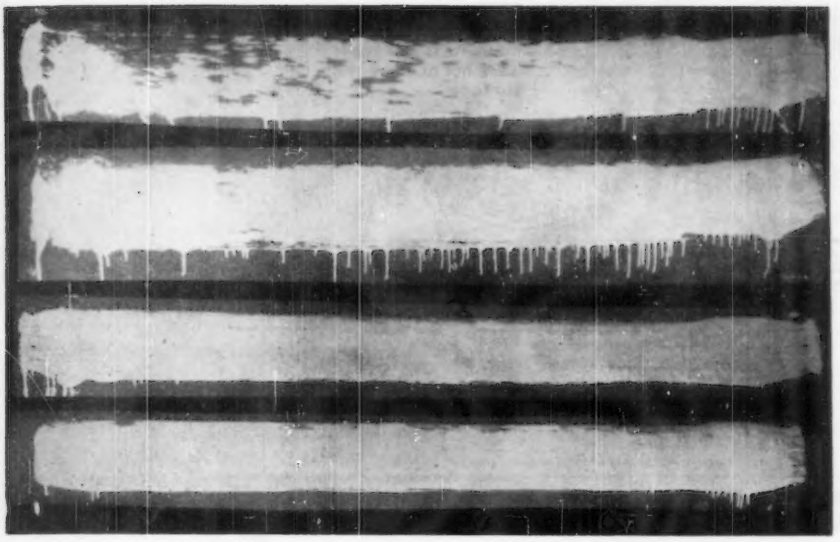

Fig. 5.—Stripes Made by Various Brushes in 8 Strokes on Painting Machine.

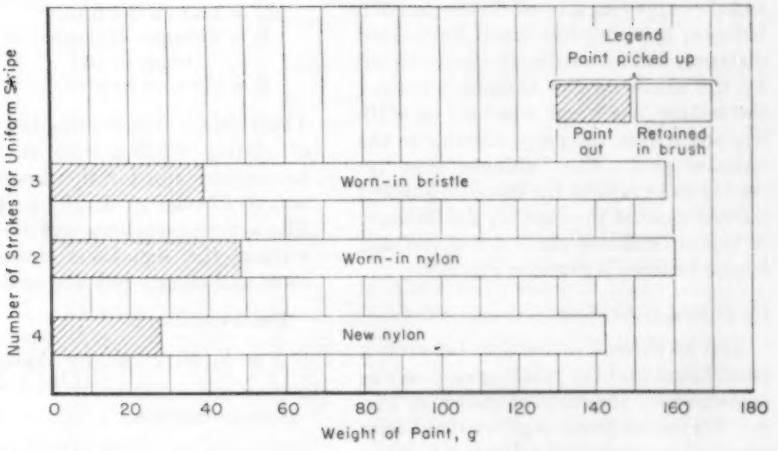

Fig. 6.—Paint Capacity of Various 4-in. Brushes.

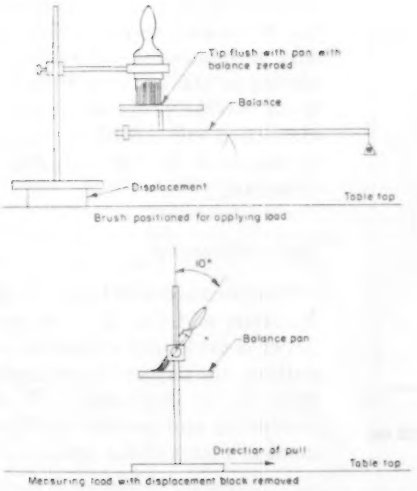

Fig. 7.—Method of Measuring Stiffness.

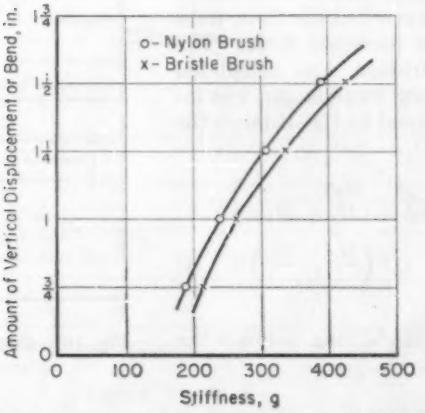

Fig. 8.—Stiffness Curves for Similar Nylon and Bristle Brushes.

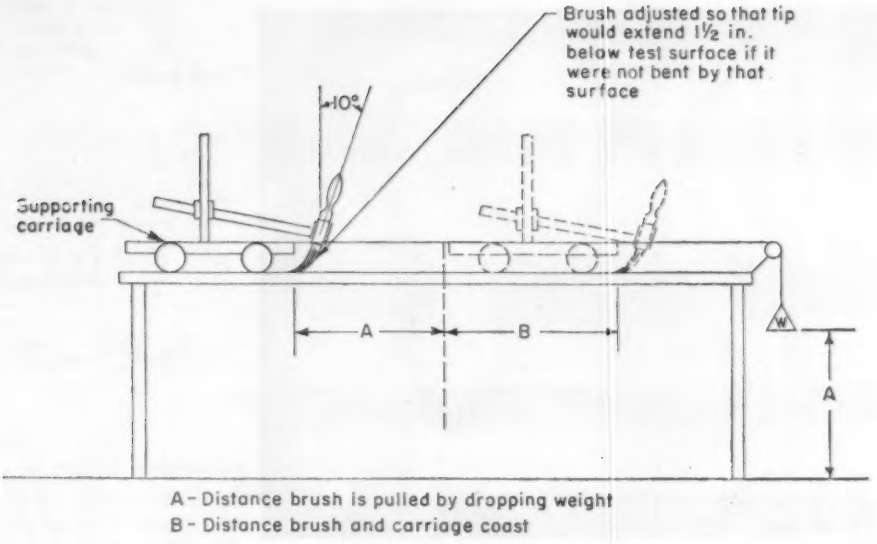
Brush adjusted so that tip would extend 1½ in. below test surface if it were not bent by that surface
10°
Supporting carriage
A
B
W
A
A - Distance brush is pulled by dropping weight
B - Distance brush and carriage coast

Fig. 9.—Method of Measuring Coefficient of Friction.

Stiffness:

The method of measuring stiffness is shown in Fig. 7. This method consisted of applying a brush to the pan of a balance, lowering the brush for a fixed distance, and measuring the load exerted by the brush on the balance. During the testing, the brush was held at a 10-deg angle from the perpendicular to the balance pan. The stiffness was recorded as a graph of the distance lowered plotted against the load on the balance. A typical stiffness curve for nylon and bristle brushes is given in Fig. 8.

Coefficient of Friction:

The coefficient of friction between a paint brush and the painting surface was measured by the method shown in Fig. 9. The paint brush was mounted on a wheeled carriage and adjusted to have the same degree of bending given brushes tested on the painting machine. The brush was held at an angle of 10 deg from the perpendicular to the test surface. The force which the brush exerted against the test surface was determined by the stiffness test described previously. The carriage was pulled by a falling weight and allowed to coast, after the weight reached the floor, until stopped by the frictional force. The coefficient of friction was calculated from the following formula and was inversely proportional to the distance the carriage coasted:

$$N_2 = M_1/M_3\left[\frac{M_2h}{M_1h + (M_1 + M_2)d}\right] - \left(\frac{M_1 - M_2}{M_3}\right)N_1 \ldots (1)$$

where:

N_2 = coefficient of sliding friction of the brush,
N_1 = coefficient of sliding friction of the carriage,
M_1 = weight of carriage,
M_2 = weight of dropping mass,
M_3 = load on the brush,
h = distance through which weight dropped, and
d = distance coasted.

This method of measuring the coefficient of sliding friction was similar to a method described in the *American Journal of Physics*, Vol. 13, p. 43 (1945). The above equation was obtained by solving the equations describing the force and energy balance in the system:

Force equation:

$$M_2g = N_1(M_1 - M_3)g + N_2M_3g + (M_1 + M_2)a \ldots (2)$$

Energy equation:

$$M_2gh = N_1(M_1 - M_3)g(h + d) + N_2M_3g(h + d) + M_2ah \ldots (3)$$

From Eq 2,

$$a = \frac{M_2 - N_1M_4 - N_2M_3}{M_1 + M_2}\,g$$

where $M_4 = M_1 - M_3$.

Substituting a in Eq 3 and solving for N_2, Eq 1 is obtained. The expression for N_1 was derived in a similar manner and was measured by conducting the test with the brush free from the surface.

The derived equation was based on the assumption that the frictional force was proportional to the load on the brush, and that the coefficient, therefore, was independent of the load. A test of this assumption, made by measuring the coefficient which various loads on the brush, showed that the coefficient of friction was independent of the load for good nylon brushes but not for bristle brushes.

The coefficients of friction for various brushes are shown in Fig 10.

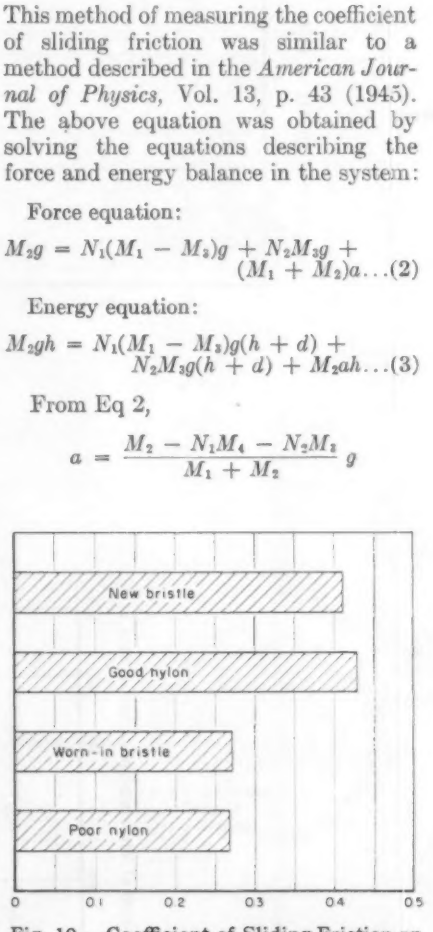

Fig. 10.—Coefficient of Sliding Friction on Wet Paint.

Snapback:

The snapback was observed by a photographic method. Each brush was struck by a swinging pendulum and the snapback and oscillations were photographed with a movie camera at eight times normal speed. A clock, graduated in hundredths of a second, was included in the scene to time the oscillations. When projected at normal speed, the action was slowed so that differences in snapback between brushes could be observed.

Acknowledgment:

The permission of the E. I. du Pont de Nemours and Co., Inc., to publish this paper is gratefully acknowledged. The authors are pleased to acknowledge the aid of M. W. Doyle and E. W. Adey who conducted and assisted in the development of many of the tests.

Hardness Measurements for Determination of Residual Stresses

By George Sines[1] and Ronald Carlson[1, 2]

THIS paper presents experimental evidence of the effect of stress on penetration hardness measurements and suggests a method for measuring residual stresses by hardness measurements. A brief analysis of the effect of uniaxial stresses on penetration hardness measurements predicts the experimental results.

Kokubo (1)[3] in 1932 performed experiments on a number of metals to show the effect of strain on hardness measurements. He applied a bending load sufficient to cause 0.003 strain on the outer fibers of the specimen and took Vickers hardness readings, using a 5-kg load, on the material in the strained state. A summary of his data is presented in Table I, and it can be seen that in all cases, except for the brass, aluminum, copper, and Armco iron, in the annealed conditions, the applied tensile stresses made the material appear 5 to 12 per cent softer while the compressive stresses caused only 0 to 3 per cent increase in apparent hardness. The strain of 0.003 exceeded the elastic limit of the annealed materials mentioned, so the resulting work-hardening increased the hardness for both the tensile and compressive stresses. The behavior of interest to this discussion is that the applied stress in the elastic range made the material appear appreciably softer when the stress was tensile, but when it was compressive it had no effect or only slightly increased the hardness indication.

A preliminary experiment performed at the University of California confirms the data of Kokubo. Figure 1 shows the amount Rockwell B hardness measurements change with applied stress for an annealed high-carbon steel specimen. The plotted points are the average values of ten hardness readings. The compressive stresses caused only a slight apparent hardening while the hardness measurements decreased approximately linearly with the applied tensile stress.

TABLE I.—EFFECT OF STRAIN ON HARDNESS MEASUREMENT, KOKUBO (1).

Material	Condition	0.003 Applied Strain	Change in Vickers Hardness	Change in Hardness, per cent
Armco Iron	rolled	+	−12.5	− 8.0
		−	2.5	2.5
	annealed	+	1.0	1.0
		−	4.0	5.0
0.2 per cent Carbon Steel	rolled	+	−15.0	−11.0
		−	2.5	2.0
	annealed	+	− 8.0	− 7.0
		−	1.0	1.0
0.7 per cent Carbon Steel	rolled	+	−22.0	− 9.0
		−	2.0	1.0
	annealed	+	−14.0	− 6.5
		−	5.0	3.0
Brass	rolled	+	−16.0	−12.0
		−	3.0	2.0
	annealed	+	− 2.0	− 1.5
		−	2.0	3.0
Aluminum	rolled	+	− 2.0	− 5.0
		−	1.0	2.0
	annealed	+	0.7	4.0
		−	1.2	6.0
Copper	rolled	+	− 9.0	−10.0
		−	0.0	0.0
	annealed	+	0.0	0.0
		−	4.0	8.0

The behavior revealed by these experiments suggests a nondestructive method for determining residual stresses in machine parts and structures: If external loads of varying degree are applied to a part while hardness measurements are taken, a state will be reached where the stress from the external load exactly nullifies the residual stress, and a transition will occur in the hardness measurements. This transition will take on two different forms depending on whether the residual stress is compressive or tensile. If the residual stress is compressive, an applied compressive stress will have little or no effect on the hardness measurements and a tensile stress also will show no effect as long as the sum of the applied stress and residual stress is compressive; but if the tensile stress is great enough so that the sum becomes tensile, the material will appear softer as the stress is increased. However, if the metal appears to increase in hardness as the applied compressive stress is increased, it is known that the sum of the applied and residual stress is still tensile; but when a compressive stress is reached that gives no further increase in the hardness measurements, the sum has become compressive. The residual stress is equal

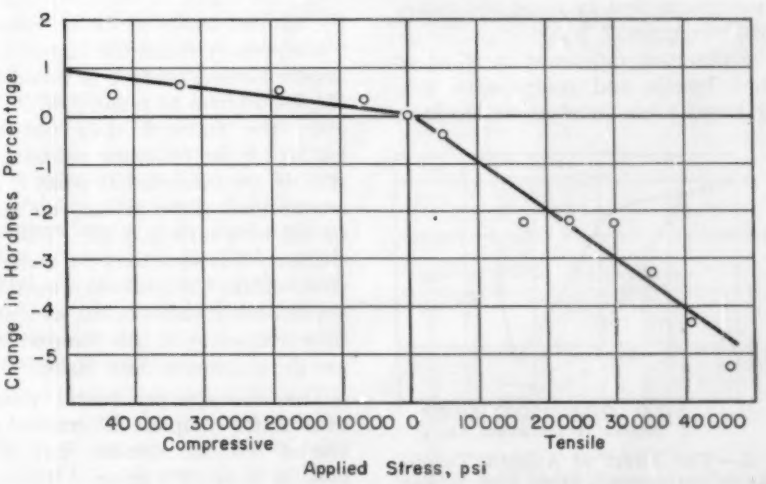

Fig. 1.—The Effect of Applied Stress on Hardness.

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[1] Department of Engineering, University of California, Los Angeles, Calif.

[2] North American Aviation, Los Angeles, Calif.

[3] The boldface numbers in parentheses refer to the list of references appended to this paper.

and opposite to the applied stress that causes this transition in hardness measurements.

It is usually possible to guess the sign of the residual stress from the nature of the treatment of the part so that one can avoid exceeding the elastic limit by starting with an applied stress opposite in sign to the residual stress. If the metal does yield, not only will the effect be masked by the work-hardening, but the residual stress pattern will have been altered by the plastic strain.

Fink and Van Horn (2) may have given a demonstration of the measurements of residual stress by hardness measurements while they were studying the effect of stress on lattice distortion in the hardening of metals. Their test specimen was $\frac{1}{8}$ by $\frac{1}{4}$ by 6-in. strip of 17S aluminum that had been quenched from 500 C. In Fig. 2 their Rockwell E readings are plotted as a function of maximum fiber stress on the bent specimen. The hardness readings are almost constant until a stress of about 8000 psi is reached, then the hardness readings decrease almost linearly with the applied tensile stress until the elastic limit of 16,000 psi is exceeded, causing the material to work-harden. According to the process outlined for determining residual stress, the transition in hardness at an applied tensile stress of 8000 psi would indicate a residual compressive stress on the surface of the specimen of 8000 psi. The indication would be expected to be low because the Rockwell indentor penetrates to a considerable depth and the residual stresses decrease rapidly in depth from the surface, so as a result the stress that causes the softening is less than the maximum surface stress.

Several other means of using hardness measurements for the determination of stress and residual stress have been proposed; however, they have not been used, because they either had to use destructive methods (6), or necessitated measurements that required too highly refined technique (7, 8).

The observed difference in effect of applied tensile and compressive uniaxial stresses on penetration hardness

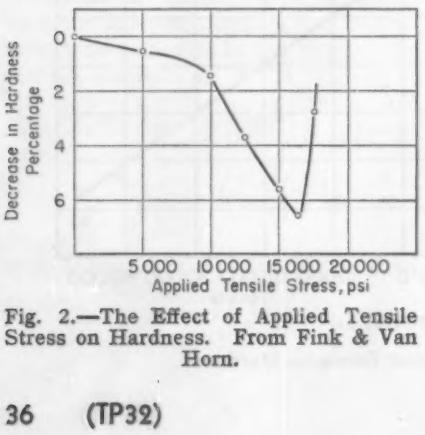

Fig. 2.—The Effect of Applied Tensile Stress on Hardness. From Fink & Van Horn.

measurements can be predicted by the following analysis. The penetration hardness tests, Brinell, Rockwell, Vickers, etc., give plastic and elastic deformations that are complicated by the strain hardening and surface friction characteristics of the metal, so the following analysis does not give quantitative results. Here it is possible to see the first-order effects by using the oversimplified maximum shear stress criterion for flow, and thus avoid the intricacies in a more refined treatment. It will be assumed that plastic deformation occurs when the shear stress on some plane exceeds the critical value.

At a point P directly beneath the indentor, the compressive stress varies inversely with the square of the distance and there are no shear stresses in the plane perpendicular to the compressive stress (3). A uniaxial tensile stress σ_r is applied perpendicular to the stress field σ_t produced by the concentrated load F of the hardness tester. The theory of elasticity shows that the maximum shear stress occurs on the planes which make an angle of 45 deg to these principal stresses so the effect of the two superimposed stress fields on the planes making an angle of 45 deg to them will be examined by considering the force equilibrium conditions on a small element at point P.

A shearing stress τ_t and a normal stress N_t must exist on the plane $ABCD$ to oppose the compressive stress in order to have equilibrium of forces on the element. It is seen that the shear stress τ_r resulting from the uniaxial tensile stress σ_r is in the same direction as the shear stress caused by the force F. The shear stress resulting from the force on the indentor decreases with the depth, so that when the shear from the tensile stress is added, the critical shear stress for plastic flow is exceeded to a greater depth, the indentor sinks deeper, and a lower hardness is measured.

It first might be expected that when the applied tensile stress is replaced by a compressive stress the material would appear harder, because it would reduce the shear stress on plane $ABCD$. However, the material does not appear harder for the following reason: If the stresses are examined at point P on the longitudinal plane making an angle of 45 deg with surface, plane $FBGC$ of the element, it is seen that the shear stress on this plane has not been altered by the applied compressive stress, so that plastic action occurs on this plane which now has the maximum shear stress.

The above experimental procedure cannot give complete information about biaxial residual stresses, but if it is possible to apply a uniaxial stress to the point in question, the difference between the two biaxial stresses can be measured. Almen (4) and Blain (5) have shown that an equibiaxial stresses compressive stress results in an equal and opposite effect, thus there would be no transition in hardness measurement if only equibiaxial stresses could be applied.

The applicability of using hardness measurements to determine residual stresses has not been extensively investigated, but it should be fully developed because it is the only nondestructive means for measuring residual stresses other than X-ray diffraction. X-ray diffraction is severely limited because the lines often become so diffuse after the metal has been work-hardened that measurements cannot be made. This limitation does not exist in the method outlined for determination of residual stresses by variation of hardness measurements. The sensitivity of the hardness measurement to residual stress can be greatly increased over that of the standard penetration testers. Blain (5) has shown that a modification of Hertz's method is very sensitive to applied biaxial stresses, and it should be equally sensitive to uniaxial stresses. The measurement consists of finding the smallest load on a 10-mm ball that will cause permanent deformation as ascertained visually by observing the reflection of light on the polished surface of the specimen. The hardness index of 337 for the unstressed steel decreased to 95.4 when a biaxial tensile stress of 235,000 psi was applied, and increased to 516 when the same magnitude of stress was applied in compression. The variation in hardness with applied stress of only a few per cent as measured by the Rockwell and Brinell hardness testers, changed to about 500 per cent by using this different method of hardness measurement. The following points

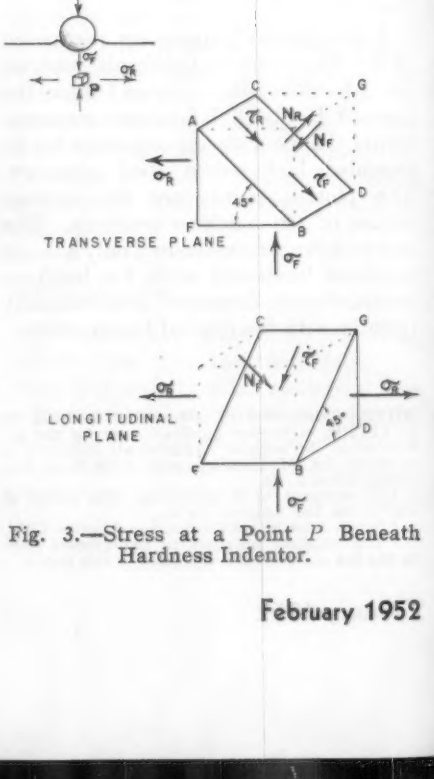

Fig. 3.—Stress at a Point P Beneath Hardness Indentor.

should be considered if the method is to be fully exploited:

1. The design of the shape of the indentors.
2. The selection of the optimum sensitivity to hardness change for the particular condition of the material in question.
3. The number of individual readings to obtain a reliable statistical average.
4. Micro-hardness techniques to reduce the damage to the surface.
5. Design of portable testers to be taken into the field.

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Heat Distortion of Polystyrene*

By K. J. Cleereman,[1] H. J. Karam,[1] and J. L. Williams[1]

SYNOPSIS

Prior to running many types of physical tests, it is customary to condition the test specimen to bring them to a uniform state. In polystyrene, this frequently results in partial annealing of the test specimen. An extensive study has been made to determine the effects of annealing during the conditioning treatment on polystyrene. The annealing variables, time and temperature, were varied over a wide range. The effects of annealing on heat distortion, crazing, and other physical properties of polystyrene were studied. Also investigated was the effect of applied load on the test bar for conditioned and unconditioned specimen.

FABRICATED thermoplastic articles will soften and deform at some elevated temperature. The physical properties of different thermoplastics at various temperatures have been investigated by several persons (2, 8, 10).[2] The maximum temperature at which plastic articles are useful depends on the properties of each individual material. There is no single easy way of predicting this maximum temperature since factors of time, applied stress, and method of loading will all have an effect in any given case. The ASTM Method D 648–45 T[3] specifies a set of conditions for determining the heat distortion temperature of plastics. This test gives information which can be used to evaluate polymers in a comparative manner.

The ASTM heat distortion test consists of applying a load at the center of a horizontally supported plastic bar. The bar is then heated at a uniform rate until a specified distortion has occurred. Figure 1 shows a schematic sketch of a heat distortion unit. The test itself is simple to operate and results are reproducible.

The theoretical significance of heat distortion data for plastics has been discussed extensively by Saurer and co-workers (11) and by Moody and Goldblum (9). From a practical viewpoint, it indicates to what temperature an object can be subjected if it is molded of a specified material. Since molded articles are intended for a wide range of uses, this is a necessary consideration.

The heat distortion test, although very useful, has certain limitations. It gives only one point on a heat distortion curve, and unless the general behavior of the material being tested is known, erroneous conclusions may be drawn. Saurer and his co-workers (11) discuss this point extensively in their article. A further limitation of the test is that it is a test of a plastic under stress, and to obtain data under no-load conditions requires performing several tests and extrapolating to zero load.

The heat distortion test should give results comparable to failure temperature of the end product in actual use. Heat distortion values obtained on polystyrene as required by ASTM Specification D 703–49 T are in many instances lower than the failure temperature of commercially molded articles.[4] This specification states that for those tests where conditioning is required, Procedure B of ASTM Methods D 618–49 T[5] shall be used. This conditioning procedure requires that the molded test specimens should be conditioned at 50 C for 48 hr.

It is the purpose of this paper to show to what extent annealing during conditioning can be expected to put polystyrene test specimens into a uniform state prior to testing for heat distortion and to show how this compares with present recommended procedures.

In this investigation, conditioning procedures for polystyrene were extended over a wide range of temperature and time. Empirical equations were derived to correlate heat distortion temperature with annealing variables. The effects of annealing on crazing and

[4] ASTM Specification for Polystyrene Molding Compounds (D 703–49 T), 1949 Book of ASTM Standards, Part 6, p. 128.
[5] ASTM Methods of Conditioning Plastics and Electrical Insulating Materials (D 618–49 T), 1949 Book of ASTM Standards, Part 6, p. 765.

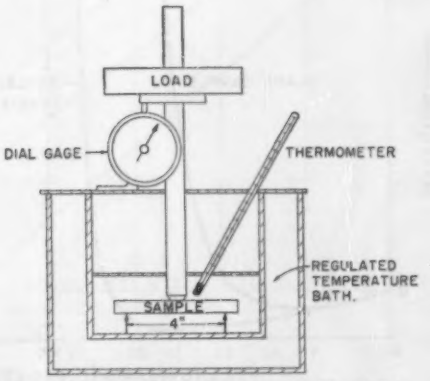

Fig. 1.—Schematic Sketch of a Heat Distortion Unit.

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* Presented at a meeting of Committee D-20 on Plastics held in Washington, D. C., March, 1951.

[1] Styron Inspection and Service Laboratory, The Dow Chemical Co., Midland, Mich.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Tentative Method of Test for Heat Distortion Temperature of Plastics (D 648–46 T), 1949 Book of ASTM Standards, Part 6, p. 128.

other physical properties of the plastic were studied. Also studied was the effect of applied load on conditioned and unconditioned polystyrene. Lastly, a brief study was initiated to determine whether the results as obtained with polystyrene are applicable to other plastics.

Effect of Conditioning Time and Temperature on Polystyrene

Three types of polystyrene were used throughout this investigation:

Type A—A general purpose, unmodified polystyrene,

Type B—A modified high impact polystyrene, and

Type C—A heat-resistant polystyrene.

Conditioning is essentially an annealing process in which the internal strains due to molding are relieved. The extent to which the strains are relieved depends largely upon the time and temperature of the annealing treatment. Articles by Bailey (1) and Dunlap, Pokigo, and Glick (3) were concerned primarily with how annealing techniques relieved strains to eliminate crazing. Kerosine and thermal cycling tests were devised to measure the degree of strain released by annealing. In this paper, the main interest is to show how proper conditioning of a sample enables one to obtain a truer index of heat distortion. Zinzow (12) showed how ASTM Conditioning Procedure B (48 hr at 50 C) increased the heat distortion temperature of polystyrene by approximately 8 C. Relieving of the internal strains accounts for this increase in heat distortion value. Actually, the heat distortion test is a measure of strain relief and would be useful as such in a laboratory. It could not be readily adapted for field tests on commercial moldings.

The injection molded samples for this study were all $\frac{1}{8}$ by $\frac{1}{2}$ by 5-in. bars. They were annealed by placing in a constant temperature bath for various times at constant temperatures. A constant temperature bath was selected because of the ease of controlling temperature over a wide range. The same results could be obtained if a hot-air oven had been used. The absorption of water or glycol by the polystyrene bar was less than 0.1 per cent, which did not appear to affect results.

Figure 2 shows temperature-deflection curves for polystyrene type *A*. The literature contains papers (6, 7, 11) on how one can obtain such curves by mechanical methods. In this laboratory, an electronic device has been used to record the deflection *versus* temperature automatically.

The solid curve of Fig. 2 represents the temperature-deflection graph of polystyrene type A, tested shortly after the specimen was molded. The dash-line curve shows the same material tested after it was annealed for three days at 160 F. As can be seen from the curves, both the blank and the annealed specimens expanded slightly before distortion began. For the blank specimen, distortion began at 40 C, while the heat distortion temperature was 74 C. Distortion occurred continuously over this 34 C range. The annealed specimen did not begin to distort until the temperature reached 76 C, and the heat distortion point was 92 C. In this case, the range in which the specimen distorted was 16 C. The rate of distortion of the annealed specimen was more rapid than that of the unannealed bar. By annealing, the start of the transition or distortion point has been increased by 36 C, while the heat distortion value increased only 18 C. This shift of the distortion initiation point would appear to have as much or more significance than the increase in the final heat distortion value.

The same effect is observed for type *C* material, shown in Fig. 3. For this material, the annealed specimen began to distort at a temperature 46 C higher than the unannealed specimen, while the increase in heat distortion temperature was 18 C.

To determine the effect of increased annealing time on polystyrene, a series of specimens was annealed at constant temperatures for various times. The heat distortion temperature of the specimen was then determined. Typical results obtained are shown in Fig. 4. This particular curve is for polystyrene type B. As can be seen from the curve, the heat distortion temperature is a linear function of the log of the annealing time. There is very little scatter in results; only at low annealing times are deviations from a straight line observed. The same types of results are obtained on types A and C polymers.

Figures 5, 6, and 7 represent similar sets of data for the three different types of polystyrene. Figure 5 shows the effect of annealing temperature and time over an extended range on polystyrene of type A, Fig. 6 for polystyrene of type B, and Fig. 7 for polystyrene of type C. One is limited in the range of temperature in which one can anneal. The limiting maximum temperature at which specimens can be annealed is the temperature just below the point of distortion for the annealing time used. In the case of polystyrene, the maximum annealing temperatures are 180 F for type *A* polymer, 160 F for type B polymer, and 200 F for type C polymer.

As can be seen, the results of annealing are similar for all three types of polystyrene. The curves for any one type of polystyrene are essentially

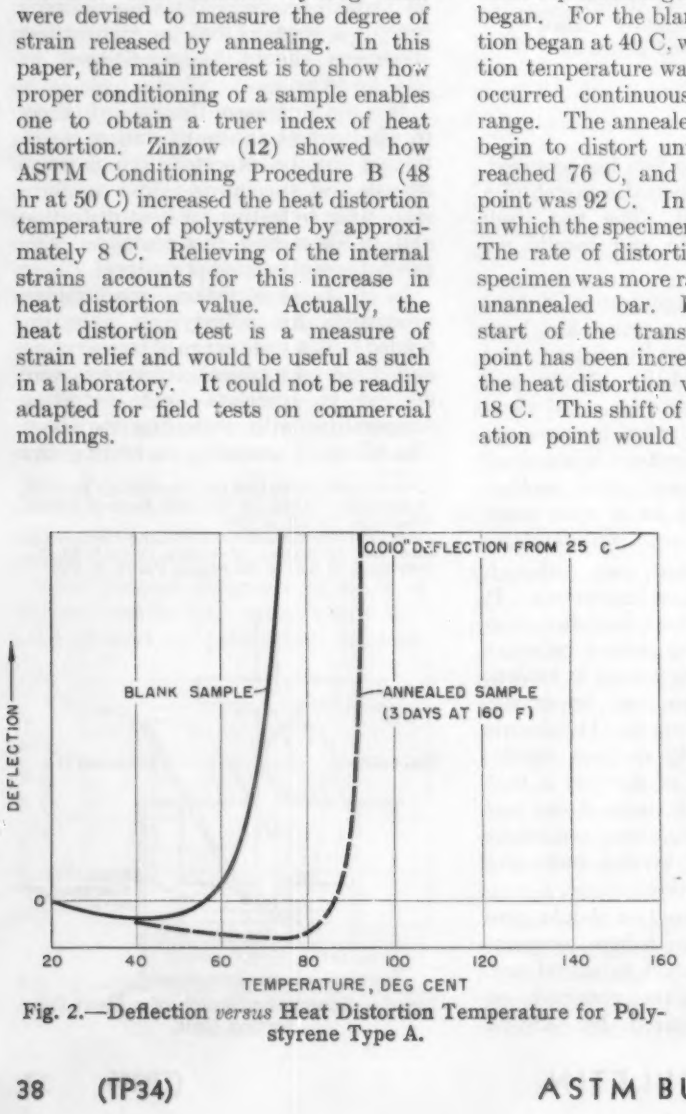

Fig. 2.—Deflection *versus* Heat Distortion Temperature for Polystyrene Type A.

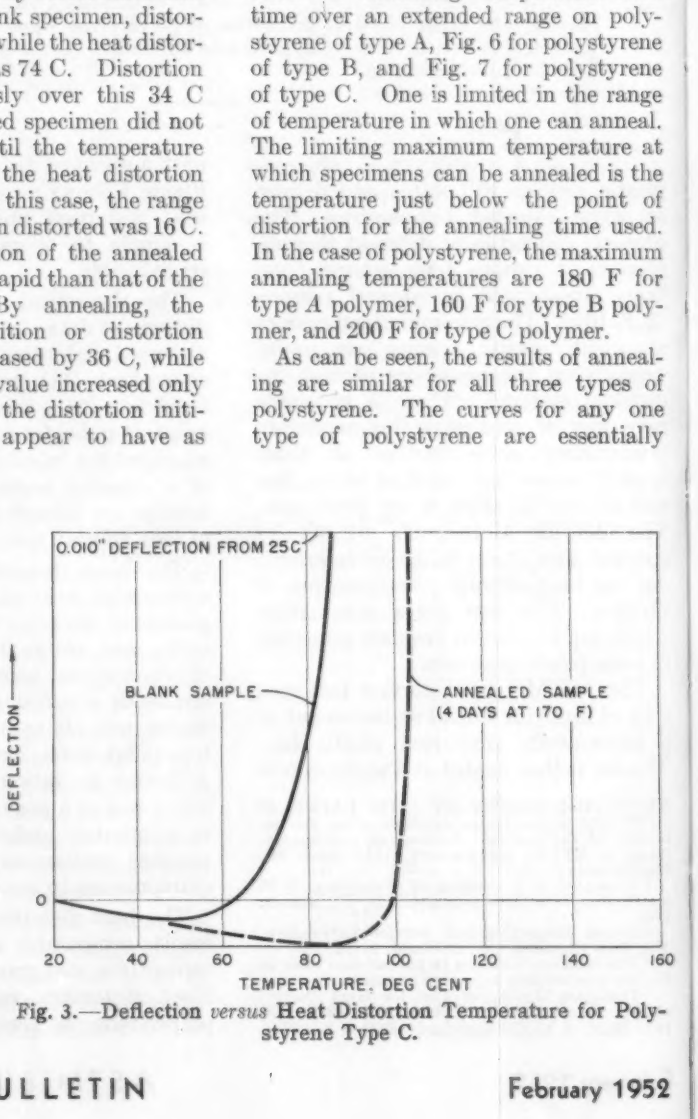

Fig. 3.—Deflection *versus* Heat Distortion Temperature for Polystyrene Type C.

parallel. At constant time, a higher heat distortion is obtained as the annealing temperature is increased.

It is evident from the curves that each type of polymer reaches a limiting heat distortion value. This value is independent of annealing time and temperature, depending only on the basic type of polymer. The conditioning technique to obtain this maximum heat distortion value is quite different from that recommended in ASTM Specification D 703–49 T.[4] Table I summarizes the results as obtained using the ASTM recommended practice as compared to the maximum heat distortion values as obtained in this investigation.

A number of advantages are gained by using the maximum heat distortion values. Present values are too erratic to be entirely meaningful. Part of these variations are due to molding technique. It will be shown later that, by using maximum values as obtained by using proper annealing techniques, these fluctuations are eliminated. For control purposes in laboratories, more reproducible results are obtained by using maximum values. Industry-wide use of maximum heat distortion temperatures will eliminate much of the differences that exist between laboratories. An important practical consequence of using maximum values is that it represents the highest temperature that articles fabricated from the plastic in question will withstand.

If commercially molded objects of polystyrene are put in a bath which is constantly increasing in temperature, they will distort at some elevated temperature. This temperature has been called the "practical heat distortion temperature." There is no general standard test method to obtain this temperature. It depends on the type of material, geometry of the object, and also on the molding technique used. Since, for polystyrene, this practical heat distortion value is usually above the ASTM heat distortion value reported, uncertainty can exist as to just what temperature the designer can use when selecting material. This is no longer true if the maximum heat distortion value, as defined in this paper, is used. This maximum value is dependent only on the type of material used and will be the highest temperature that the molded objects could be expected to withstand. The practical heat distortion value will usually be at or near the maximum heat distortion value reported. If it is not, the molder, by adjusting molding conditions or by mold design, will be able to approach the maximum heat distortion value. It gives him the knowledge he needs to

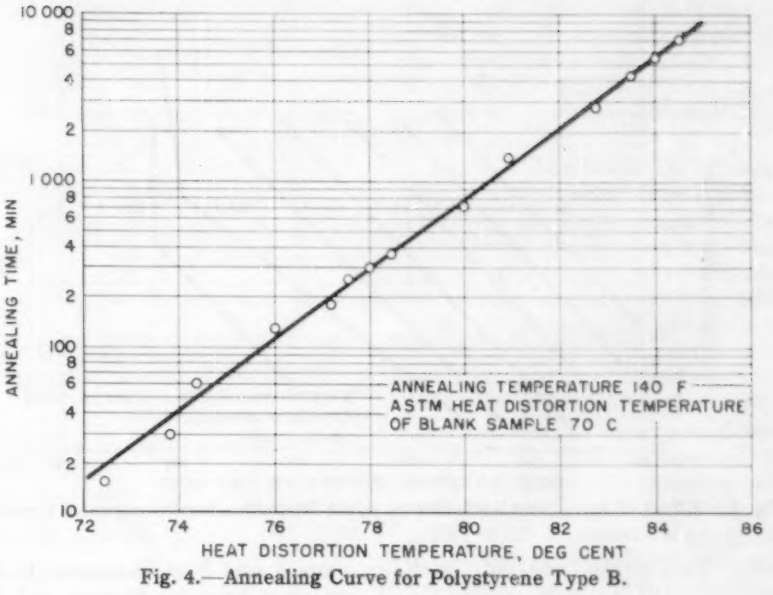

Fig. 4.—Annealing Curve for Polystyrene Type B.

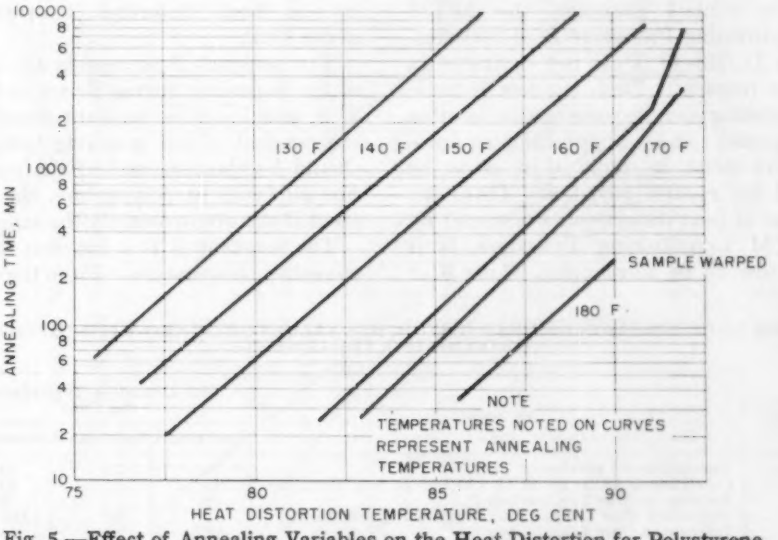

Fig. 5.—Effect of Annealing Variables on the Heat Distortion for Polystyrene Type A.

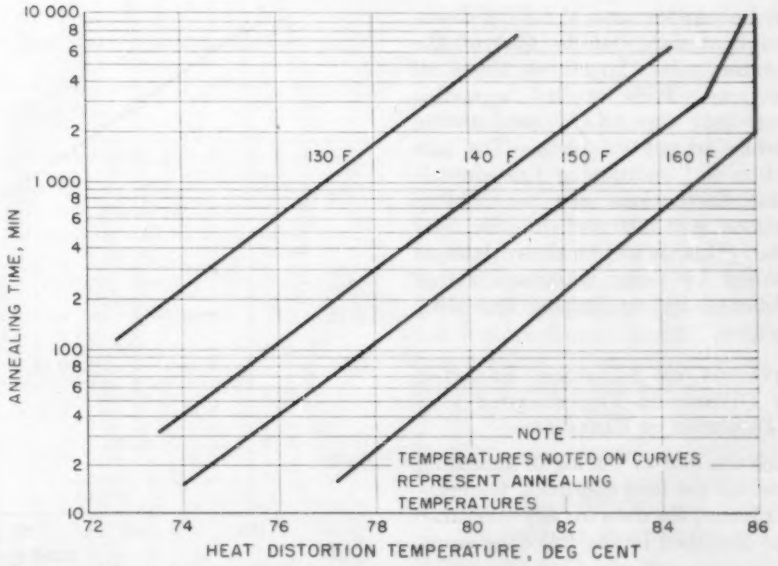

Fig. 6.—Effect of Annealing Variables on the Heat Distortion for Polystyrene Type B.

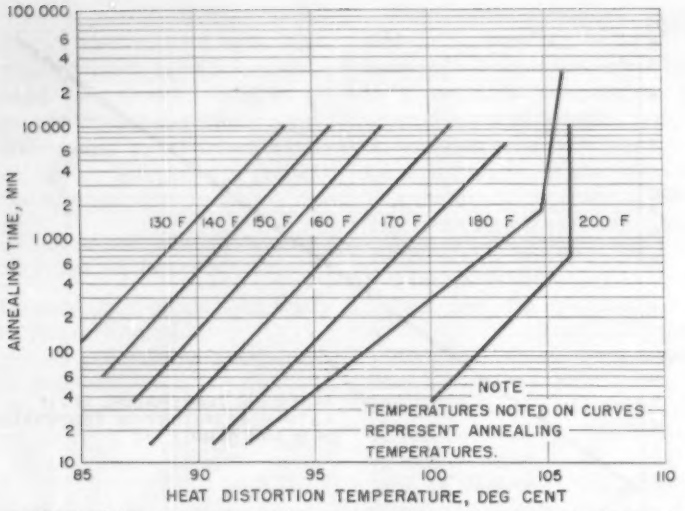

Fig. 7.—Effect of Annealing Variables on Heat Distortion for Polystyrene Type C.

properly handle the material being molded.

For control purposes, the ASTM Conditioning Procedure B of Specification D 618–49 T[5] is not desirable in some respects. First, the test is time-consuming and, because of this, is often by-passed since a conditioning procedure must be rapid if it is to be used for control purposes. Then, the value of heat distortion as obtained by ASTM Conditioning Procedure B is too low to be meaningful. Line 6 of Table I shows the ratio of ASTM conditioned heat distortion to that of the maximum value for three types of polystyrene. It is evident from this column that the ASTM conditioning procedure is not complete. The last objection to Conditioning Procedure B is that fluctuations due to molding conditions are mirrored in the final results. This, as will be shown later, is minimized by using maximum values as obtained by maximizing annealing techniques.

TABLE I.—COMPARISON OF HEAT DISTORTION VALUES OBTAINED WITH DIFFERENT CONDITIONING TREATMENTS.

Line	Remarks	Heat Distortion Temperature, deg Cent		
		Specimen A	Specimen B	Specimen C
1.....	Unconditioned specimen	74	70	83
2.....	Conditioned 48 hr at 50 C, (ASTM D 618, Proc. B)	82	77	89
3.....	Increase in (line 2 minus line 1)	8	7	6
4.....	Maximum after 100 per cent conditioning treatment	91	86	106
5.....	Increase in (line 4 minus line 1)	17	16	23
6.....	Ratio of increase in conditioning at 50 C to maximum conditioning treatment. (Line 3 to line 5)	0.47	0.44	0.26

Derivation of Equation Relating Heat Distortion Temperature as a Function of Variables

Since the plot of the log of annealing time *versus* the heat distortion temperature is linear, the data for any one curve can be described by the following equation:

$$t_A = Ae^{BT_{H.D.}} \quad \ldots\ldots (1)$$

where A and B are constants, t_A is the annealing time in minutes, and $T_{H.D.}$ is the heat distortion temperature in deg Cent.

The constant B represents the slope of the annealing curves shown in Figs. 5, 6, and 7. This constant should be independent of the annealing time and should be characteristic of the plastic. For all types of polystyrene, the constant B was approximately the same.

The constant A is a function of the annealing temperature. From the data, it was determined that

$$A = e^{-(C + DT_A)} \quad \ldots\ldots (2)$$

where C and D are arbitrary constants and T_A is the annealing temperature in deg Cent. This equation can be verified by showing that the plot of log A *versus* annealing temperature is linear. Figure 8 illustrates this for type A polymer. The same type of curve is obtained for the other types of polymer.

Combining Eqs 1 and 2, we have

$$t_A = e^{-(C + DT_A) + BT_{H.D.}} \quad \ldots\ldots (3)$$

For convenience in calculation, Eq 3 is written in the following form:

$$T_{H.D.} = \frac{\log_{10} t_a + C' + D'T_a}{B'} \quad \ldots (4)$$

where:

$$C' = \frac{C}{0.434},\ B' = \frac{B}{0.434},\ \text{and}\ D' = \frac{D}{0.434}$$

In converting the equation from natural logarithms to that of base ten, the factor 0.434 is introduced.

The constants C', D', and B' are listed in Table II for the different types of polystyrene.

TABLE II.—ANNEALING CONSTANTS FOR POLYSTYRENE.

	C'	D'	B'
Type A.....	9.490	0.0845	0.2096
Type B.....	7.192	0.111	0.2113
Type C.....	11.097	0.100	0.2198

Since Eq 4 is an empirical relationship, it is valid only in regions where Eq 1 is true.

Effect of Conditioning Polystyrene at Room Temperature

If a molded polystyrene object is left at room temperature for a finite

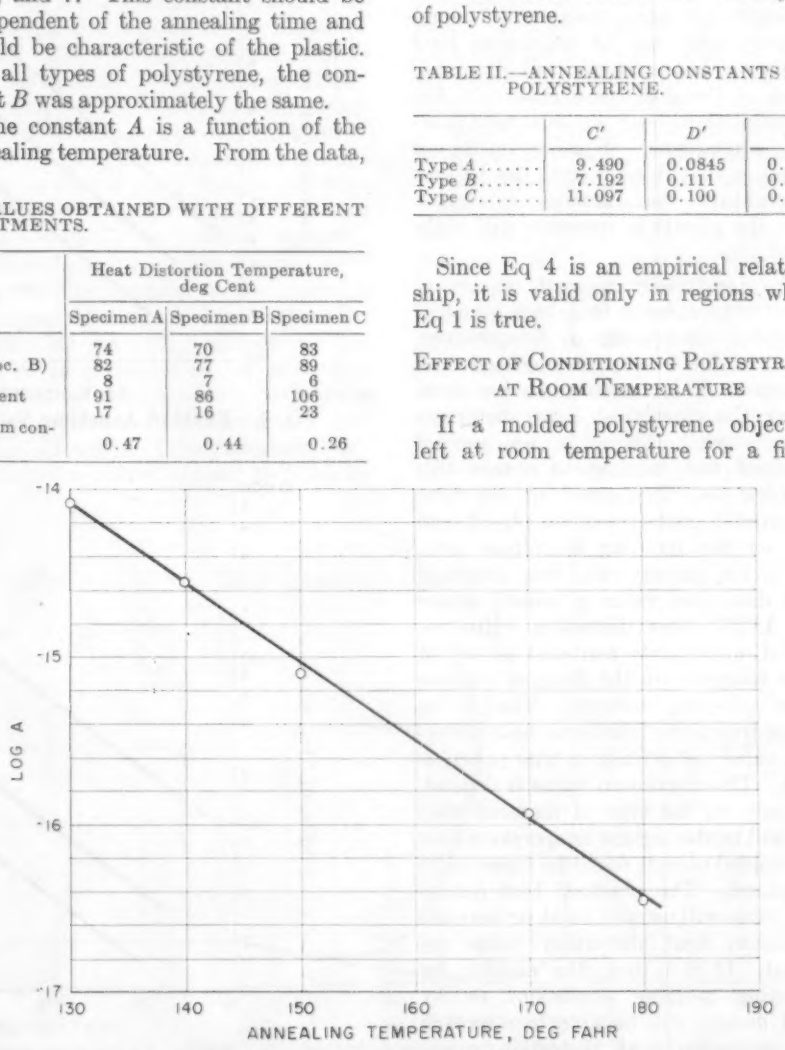

Fig. 8.—Log *versus* Annealing Temperature for Polystyrene Type A.

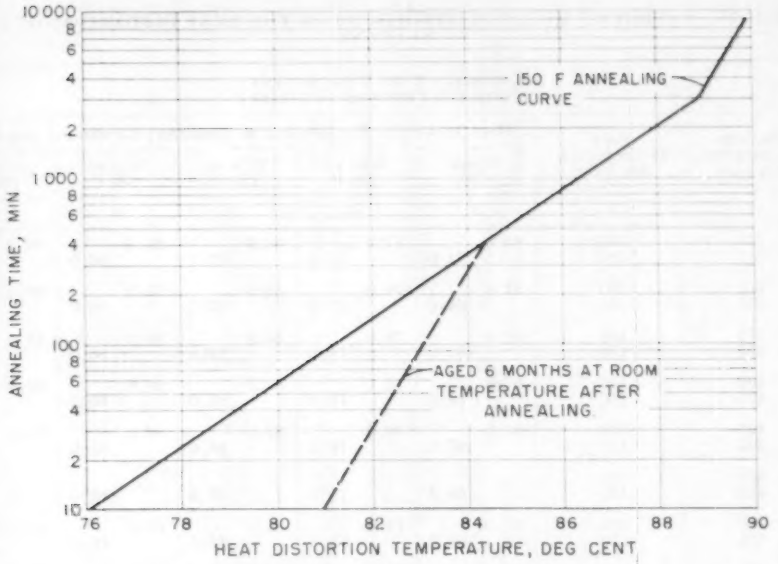

Fig. 9.—Aging Curve for Type A Polystyrene.

length of time, it will be partially annealed. On the basis of this statement, it was calculated by Eq 4 that if a heat distortion bar of type C polystyrene were conditioned at room temperature for six months, its heat distortion temperature would be 86.7 C. Experimentally, this value was found to be 86.0 C. Annealing at room temperature for six months effectively increased the heat distortion value by 3 C. The calculation was extended to determine the length of time a bar of type C polymer must be conditioned at room temperature to approach maximum heat distortion value. This time was determined to be approximately 10,000 years. In other words, it takes an infinitely long time for a bar to attain maximum heat distortion temperature when annealed at room temperature. However, changes are such that bars cannot be prepared and tested at indeterminate future times and check with results obtained at other times. This fact must be considered in any heat distortion test on polystyrene.

Figure 9 shows two sets of data for type A polystyrene. The dashed line represents the annealing curve of aged polystyrene; the solid line is the annealing curve of unaged polymers. Aging consisted of leaving annealed specimens at room temperature for six months prior to testing. The two curves do not coincide until the annealing time is above 400 min. Below this point, the aged specimen has higher heat distortion value. This is to be expected, since aging is essentially an annealing process at room temperature.

Figure 10 represents similar sets of data for type C polystyrene. Again, the two curves do not coincide until the annealing time is above 400 min. Below this point, the heat distortion temperature of the aged specimen is greater than that of the unaged specimen. The difference of the two is not as great as for the type A polymer. This is to be expected since type C has a higher heat resistance.

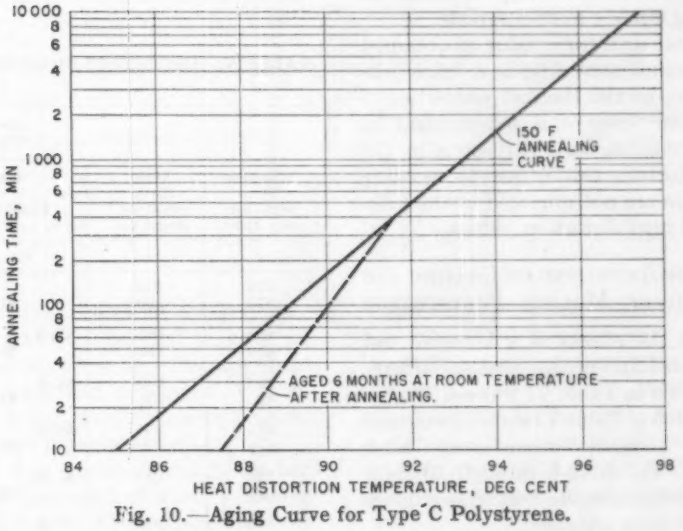

Fig. 10.—Aging Curve for Type C Polystyrene.

TABLE III.—EFFECT OF MOLDING CONDITIONS ON THE HEAT DISTORTION OF POLYSTYRENE.

MATERIAL—TYPE A POLYSTYRENE.
CYCLE AND PRESSURE—CONSTANT.

Machine Temperature, deg Fahr	Mold Temperature, deg Fahr	Heat Distortion Temperature at Annealing Conditions deg Cent			
		Blank	6 hr at 130 F	6 hr at 160 F	6 hr at 180 F
1	2	3	4	5	6
350	100	72.0	77.0	86.0	88.0
350	150	74.5	80.0	86.0	87.0
375	100	72.5	78.0	86.0	87.5
375	150	74.0	79.0	86.0	87.5
400	100	72.5	77.5	86.0	87.5
400	150	73.0	78.0	84.0	88.0
425	100	71.5	78.5	86.5	87.5
425	150	74.5	78.5	86.0	87.5
475	100	71.0	78.0	86.0	87.0
475	150	72.0	78.0	86.0	87.0
525	100	..	..	..	..
525	150	72.0	77.0	85.5	87.0
575	100	72.0	77.0	..	..
575	150	69.5	80.0	..	87.5
Range of values		5.0	3.0	2.0	0.5

For the present, no significance has been placed on the fact that both aged specimens coincided with the annealing time-temperature curve at 400 min. Longer aged specimens were not available nor were specimens annealed at different temperatures. It is not expected that the same 400-min point would be the intercept if they were.

EFFECT OF MOLDING CONDITIONS FOLLOWED BY MAXIMUM ANNEALING ON THE HEAT DISTORTION TEMPERATURE OF POLYSTYRENE

The effect of molding variables on heat distortion is shown in Table III

for type A polystyrene, Table IV for type B, and Table V for type C. For all three types of polystyrene, the heat distortion of the blank sample (column 3) is a function of molding conditions. Higher mold temperatures give higher heat distortion values, while higher plastic temperatures give lower heat distortion values.

It is possible to show some changes in strain pattern when specimens molded under different conditions are viewed through crossed polaroids. Annealing may change these patterns. Such changes have not been completely investigated and will not be discussed here, but many of the factors that may cause strain in injection moldings and which may cause the results observed have been discussed elsewhere (**4, 5**).

Columns 4 through 7, Tables III, IV, and V, show the heat distortion temperature of the various specimens annealed different amounts. As shown in the last line of each table, the range of variations progressively decreases as annealing is made more complete.

The heat distortion value as obtained by maximum annealing is a more reliable index to the thermal properties of polystyrene since it is independent of molding conditions. Variations in the heat distortion values due to molding techniques are not mirrored in the fully annealed heat distortion values.

Effect of Annealing on Crazing and Blushing of Molded Polystyrene

To see the effects of a kerosine test on annealed and unannealed specimens, work shown in Table VI was performed.

Column 5 of Table VI shows specimens put in kerosine immediately after molding. Columns 6 through 10 show the effects of a kerosine test on specimens that have been annealed.

The specimens after annealing did not craze or blush as markedly as did the unannealed specimens. Crazing and blushing, in this case, are not only a function of the annealing technique but also of the molding conditions (**5, 8**). With a selected set of molding conditions and proper annealing, no blushing or crazing occurred.

Crazing and blushing are generally considered as being caused by finite cracks, the only difference being one of degree. As used here, "crazing" refers to definitely observable cracks whereas "blushing" refers to the condition where the cracks are so fine that the surface has a white frosted appearance.

Effect of Annealing on Tensile, Elongation, and Impact Strength of Polystyrene

Apparently annealing has little effect on the physical properties of polystyrene.

TABLE IV.—EFFECT OF MOLDING CONDITIONS ON THE HEAT DISTORTION OF POLYSTYRENE.

Material—Type *B* Polystyrene.
Cycle and Pressure—Constant

Machine Temperature, deg Fahr	Mold Temperature, deg Fahr	Heat Distortion Temperature at Annealing Conditions, deg Cent									
		Blank		6 hr at 130 F		6 hr at 150 F		6 hr at 170 F		12 hr at 170 F	
1	*2*	*3*		*4*		*5*		*6*		*7*	
325	100	68.0		77.0		82.0		86.5		86.5	
325	150		71.0		77.0		82.5		86.0		86.0
350	100	67.0		76.0		83.0		86.0		86.0	
350	150		69.0		77.0		82.5		86.0		86.0
375	100	66.0		76.0		83.0		86.0		86.0	
375	150		68.0		76.0		82.0		86.0		..
400	100	66.0		76.0		82.0		86.0		86.0	
400	150		68.0		76.0		82.0		86.0		86.0
425	100	65.0		76.0		82.0		86.0		86.0	
425	150		67.0		76.0		83.0		86.0		85.5
450	100	..		..		..		..		..	
450	150		68.0		75.0		82.5		86.0		86.0
475	100	65.0		75.0		82.0		86.0		85.0	
475	150		68.0		75.0		82.5		86.0		86.0
525	100	64.0		76.0		82.0		86.0		86.0	
525	150		67.0		75.0		82.5		85.0		..
575	100	64.0		74.0		80.0		84.0		..	
575	150		67.0		76.0		82.5		84.5		..
Range of values.....		7.0		3.0		3.0		2.5		1.5	

TABLE V.—EFFECT OF MOLDING CONDITIONS ON THE HEAT DISTORTION OF POLYSTYRENE.

Material—Type *C* Polystyrene.
Cycle and Pressure—Constant.

Machine Temperature, deg Fahr	Mold Temperature, deg Fahr	Heat Distortion Temperature at Annealing Conditions, deg Cent									
		Blank		6 hr at 150 F		6 hr at 180 F		6 hr at 200 F		12 hr at 200 F	
1	*2*	*3*		*4*		*5*		*6*		*7*	
375	100	..		..		...		...		...	
375	150		87.0		92.0		99.0		...		107.0
400	100	83.5		92.0		99.0		104.0		106.0	
400	150		86.0		91.0		100.0		105.0		106.0
425	100	84.0		91.0		100.5		104.0		106.5	
425	150		84.5		91.5		100.5		104.0		106.0
475	100	82.0		90.0		101.0		104.0		106.5	
475	150		83.0		91.5		100.5		105.0		106.0
525	100	81.0		89.0		100.0		103.0		106.0	
525	150		83.0		91.0		...		104.0		...
575	100	80.0		90.0		99.0		103.0		...	
575	150		83.0		92.0		...		...		...
Range of values.....		7.0		3.0		2.0		2.0		1.0	

Tables VII and VIII summarize the results for types A and C polystyrene. Annealing has a more marked effect on type C than on type A.

A full time-temperature annealing relationship has not been explored for tensile strength, per cent elongation, and impact strength. However, for the one annealing temperature studied, there is very little difference in specimens annealed different lengths of time.

Effect of Fiber Stress on Annealed and Unannealed Polystyrene

It has been recognized that some materials are affected considerably in their heat resistance by the applied load. ASTM Method D 648 – 49 T[5] recognizes this by requiring testing at 264 psi and 66 psi to determine the sensitivity to load.

Figure 11 shows the effect of different fiber stress on the resultant heat distortion value of annealed and unannealed type A polystyrene. The fiber stress was varied by changing the load applied to the center of the test bar.

In all cases, whether the specimen was annealed or unannealed, the heat distortion temperature is a linear function of the log of the fiber stress. However when the specimen was annealed, the slope of the curves increased. This indicates that the total effective stress is less in annealed specimens than in the unannealed specimens of polystyrene. The total effective stress in this paper is defined as the sum of the externally

TABLE VI.—EFFECTS OF MOLDING AND ANNEALING ON CRAZING OF POLYSTYRENE.

Specimen	Mold Temperature, deg Fahr	Machine Temperature, deg Fahr	Machine Pressure, psi	No Annealing. In Kerosine 3 days at Room Temperature	Annealed 3 days at 150 F. In Kerosine 3 days	No Annealing. Specimen Aged 4 months at Room Temperature Followed by 3 days in Kerosine	Specimen Aged 4 months at Room Temperature then annealed 6 hr at 122 F Followed by 3 days in Kerosine.	Specimen Aged 4 months at Room Temperature then annealed 6 hr at 150 F Followed by 3 Days in Kerosine.	Specimen Aged 4 months at Room Temperature then annealed 6 hr at 176 F Followed by 3 Days in Kerosine.
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
No. 1...	130	330	1200	B	B				
No. 2...	130	350	1200	B & C	B	B	B & C	B	B
No. 3...	130	375	1200	B & C	B				
No. 4...	130	400	900	C	B	SB	B & C	SB	SB
No. 5...	130	425	900	C	B				
No. 6...	130	450	900	C	SB	C	SB & C	SB	SB
No. 7...	130	475	800	C	SB				
No. 8...	130	500	700	C	UN	C	C	UN	UN
No. 9...	130	525	600	C	UN				
No. 10...	160	350	1200	B	B				
No. 11...	160	375	1200	B	B	B	B & C	B	SB
No. 12...	160	400	1100	B	B				
No. 13...	160	425	1000	B & C	SB	SB	SB & C	SB	SB
No. 14...	160	450	800	C	SB				
No. 15...	160	475	700	C	SB	SB	SB & C	SB	UN
No. 16...	160	500	600	C	UN				
No. 17...	160	525	500	C	UN	SC	C	UN	UN

Code: C—Crazed; B—Blushed; S—Slight; UN—Unchanged.

TABLE VII.—PHYSICAL PROPERTIES OF ANNEALED POLYSTYRENE TYPE A.

Type A Polymer—Annealing Temperature 65 C ± 2 C.

Annealing Time, hr	Tensile Strength, psi	Elongation, per cent	Impact Strength, ft-lb per in. notch
0.....	6610	1.50	0.37
2.....	6688	1.60	0.41
3.....	6640	1.60	0.42
4.....	6680	1.55	0.40
6.....	6640	1.55	0.39
24.....	6624	1.45	0.39
72.....	6608	1.50	0.41

TABLE VIII.—PHYSICAL PROPERTIES OF ANNEALED POLYSTYRENE TYPE C.

Type C Polymer—Annealing Temperature 70 ± 2 deg

Annealing Time, hr	Tensile Strength, psi	Elongation, per cent	Impact Strength, ft-lb per in. notch
0.....	7774	1.65	0.33
2.....	7968	1.85	0.38
6.....	8192	2.05	0.32
12.....	8336	1.90	0.37
24.....	8352	1.80	0.38
96.....	8320	1.65	0.31

applied load and any internal stresses present. Since annealing relieves the internal stresses, the total effective stress is reduced.

Figure 2 showed that a loaded specimen exhibits thermal expansion effects until some transition temperature is reached where distortion caused by some stress takes place. This transition point was shown to increase as the specimen is annealed. This is to be expected, since annealing lowers the total effective stress.

Effect of Annealing on the Heat Distortion of Other Thermoplastics

A short study was initiated to determine if the results obtained on polystyrene would be true for other types of thermoplastics. The ASTM heat distortion value of the annealed specimens was obtained and compared with the heat distortion of unannealed specimens. Table IX summarizes results.

TABLE IX.—EFFECT OF ANNEALING ON HEAT DISTORTION TEMPERATURE.

Material and Annealing Conditions	Heat Distortion Temperature, deg Cent		Temperature, deg Cent, Increase	Per Cent Increase
	Unannealed	Annealed		
Tenite II, 4 days at 45 C	46.5	46.5	0	0
Plexiglas, 4 days at 75 C	79.0	93.0	14	17.7
Ethocel, 4 days at 45 C	51.0	56.5	5.5	10.8

There is an improvement in the heat distortion temperature when specimens of Plexiglas and Ethocel are annealed. Tenite II, however, did not show any improvement upon annealing. This indicates that conditioning standards must be set up for each type of plastic before a more accurate value of heat distortion can be obtained.

Whether the results obtained with polystyrene are true for the other plastics requires more exhaustive investigation.

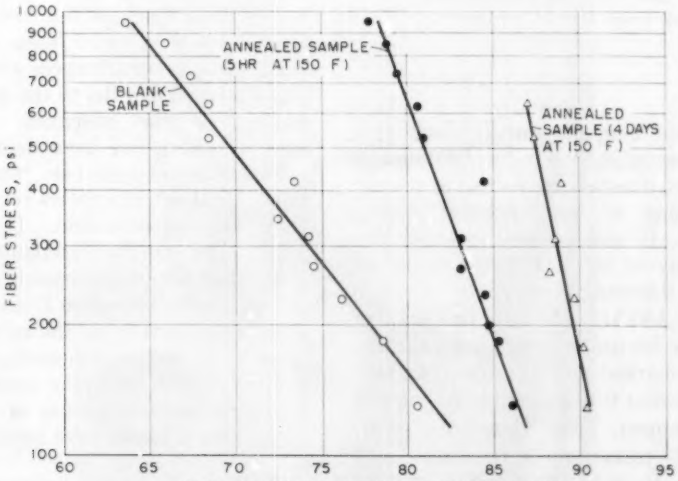

Fig. 11.—Effect of Fiber Stress on Heat Distortion Temperature for Polystyrene Type A.

Conclusion

Annealing of polystyrene results in raising the measured heat distortion temperature. This temperature is a function of annealing time and temperature. This is true for all three types of polystyrene investigated.

For all types of polystyrene considered, a maximum heat distortion temperature is obtained. This value is a reliable index for control purposes, since it is independent of molding conditions, aging conditions, and annealing techniques. From a practical viewpoint, this maximum value represents the uppermost temperature at which fabricated articles made from the given plastic may be considered for use.

Some physical properties such as crazing improve upon annealing. However, tensile strength, elongation, and impact strength show little change.

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An Electrical Extensometer for Determining Elongation of Elastomers

By C. H. Klute,[1] C. J. Penther,[1] and L. B. McKee[1]

SYNOPSIS

In the ASTM Tentative Method of Tension Testing of Vulcanized Rubber (D 412 – 49 T)[2] a device has been needed to record accurately and automatically the elongation of the reduced section of the specimen throughout the test without interfering in principle or in fact with the test and its attendant manipulations. This paper describes such an extensometer. It has been so designed that the specimen contributes only a negligible amount of energy to the sensitive elements of the instrument. This energy serves only to energize shaded pole motors through thyratron circuits and the motors so energized then contribute the power to operate the extensometer.

The extensometer comprises two light dural carts which move along a track parallel to the direction of stretching. A cable runs from each cart over pulleys to a remote drive motor. Sensitive elements, carried on each of the two carts, contact the specimen at points corresponding to the upper and lower bench mark position, respectively, and accomplish the motor control.

The extensometer is easily attachable to the conventional rubber testers. It selects the initial 1-in. separation of reference points, follows the extension continuously, spark-indicates the loads at each 100 per cent elongation, and indicates the elongation at break. It is adaptable to drawing load-elongation diagrams and to operation below and above normal temperatures.

This apparatus allows the routine determination of tensile properties with an accuracy exceeding that of techniques generally employed today and simultaneously reduces the labor involved in the test. It has been shown to be successful with materials ranging in stiffness from almost gummy to almost horny.

For some time, a need has existed for a convenient means of measuring the extension experienced by a rubber specimen when tested in tension in accordance with the ASTM Method.[3] A satisfactory method would eliminate the subjective effects of operator coordination and judgment, be suitable for use at temperatures above and below room temperatures, and be adaptable to recording the entire load-deflection curve if necessary instead of merely determining a few specified points thereon. It should not increase the complexity of the test or the length of time per determination.

In the ASTM procedure, two parallel gage lines for use in determining elongation are marked on the reduced section perpendicular to the longitudinal axis of the specimen. The lines are symmetrically placed about the center and are generally 1 in. apart. The method states that provision shall be made for measuring the elongation by a scale graduated to 0.1 in. and suitably attached to measuring trammel points or held back of the test specimen.

The ASTM method has been found unsatisfactory because it is limited to use at room temperature, and because the bench marks spread at high elongations making it difficult to follow the reference points. These disadvantages plus the fatigue experienced by the operators encouraged us to design an automatic measuring device. In particular, a device was required which would operate satisfactorily in an enclosure within which the atmosphere was controlled to temperatures above or below room temperature.

Early experiments leading up to this development were performed with a variety of devices which in one way or another depended upon the friction between the rubber of the specimen and metal probes to cause linear motion of small cart-like contrivances which moved along a track parallel to the direction of stretch of the specimen. Although such a system has been described and used,[4] our experiences with purely mechanical extensometers revealed that they are objectionable. In the first place, any purely mechanical device must abstract an appreciable amount of energy for its operation from the specimen being tested; in the second place, in order to secure sufficiently high frictional forces to cause the carts to follow the corresponding points in the specimen, normal forces were required which

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Shell Development Co., Emeryville, Calif.

[2] 1949 Book of ASTM Standards, Part 6, p. 887.

[3] Tentative Methods of Tension Testing of Vulcanized Rubber (D 412 – 49 T), 1949 Book of ASTM Standards, Part 6, p. 887.

[4] G. J. Albertoni, "A New Autographic Machine for Testing Tensile Properties of Rubber," *Analytical Edition*, Vol. 3, p. 236 (1931).

were great enough to distort the stretched specimen from the plane in which stretching occurred.

Apparatus

General:

The extensometer is shown in Fig. 1 installed on the Scott, model L-6 rubber tester. The angle-iron frame is not an essential part of the installation; it is merely the skeleton of the insulated enclosure which is presently constructed about the tester to allow high-temperature measurements of tensile properties. In the figure, transparent plastic has been secured to the frame to prevent broken rubber specimens from flying about during our early experiments with the extensometer.

The subassembly of the follow-up system including the motor drive units is shown in Fig. 2. This subassembly is mounted in the cabinet by the combined sleeve and thrust bearing, seen below the base of the carriage guide rods, and a pivot bearing at the top. The fixed flange of the lower bearing carries a detent block which locates the assembly in the operating and loading positions. A handle, seen in Fig. 1 as the vertical rod in the center of the front panel at the bottom, swings this assembly into the operating position with the carriage control fingers in contact with the specimen, or out of the way with the rod and carriage assembly in the right front corner of the cabinet. The small rectangular block on top of the box housing the drive unit is a mechanical interlock which prevents manual release of the lower clamp drive with its attendant rapid ascent which might harm the contact fingers and carriages. An electrical limit switch prevents over-travel and damage to the tension drive mechanism.

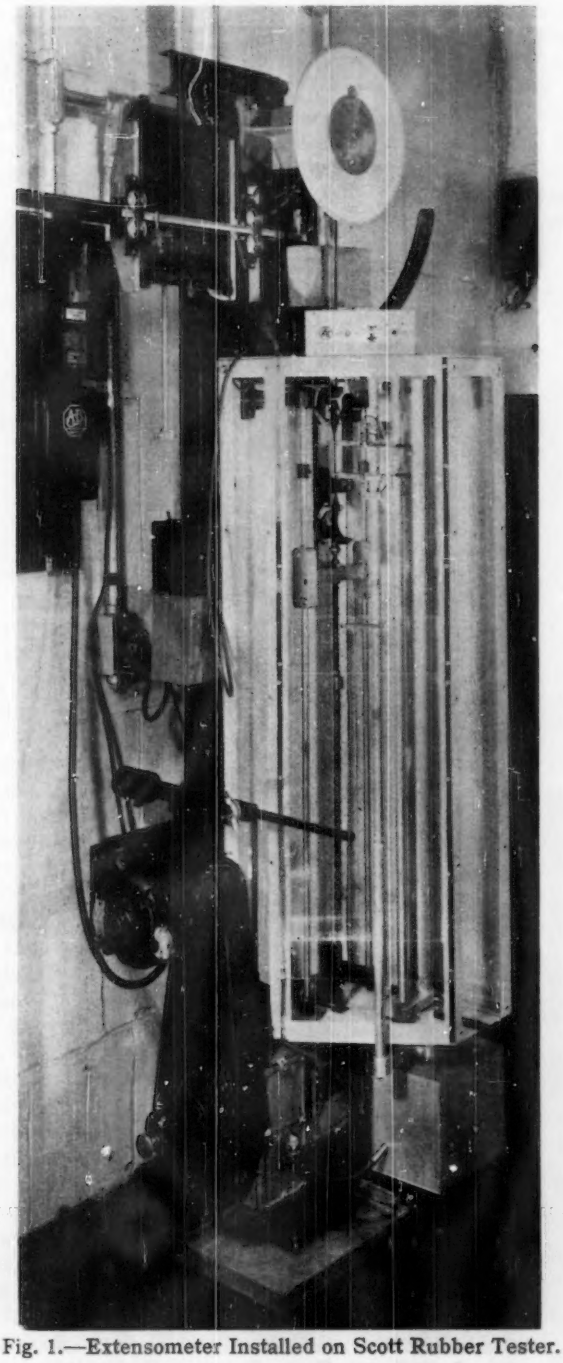

Fig. 1.—Extensometer Installed on Scott Rubber Tester.

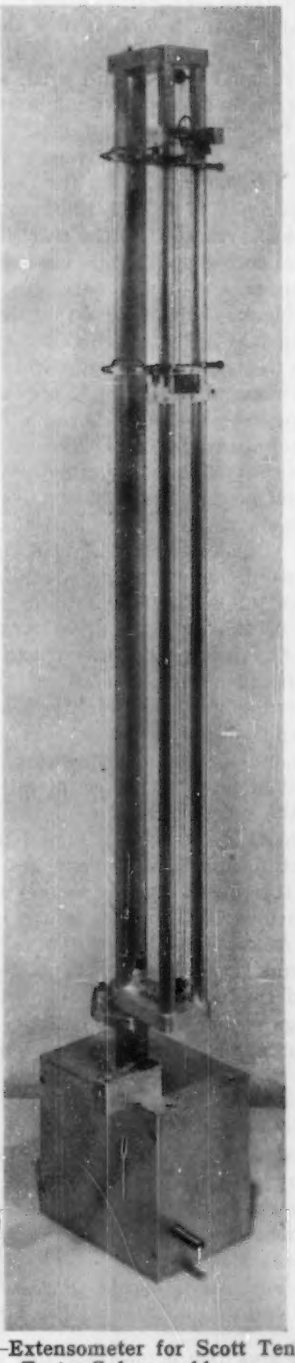

Fig. 2.—Extensometer for Scott Tensile Tester Subassembly.

Follow-up Carriages:

A close-up view of the follow-up carriages in contact with the test specimen is shown in Fig. 3. The carriages are fastened to endless stainless steel[5] drive cables which are threaded down through the hollow support column to the drive drums. By insulating these cables electrically and providing pickup brushes on the drive drums they are also made to serve as control leads for the electronic relay motor control circuits and thus eliminate dangling connecting wires.

The carriages consist of two skeletonized side panels between which are supported three spool-type wheels, two of which bear on the front guide rod with the third spring loaded against the rear guide rod. By using parallel cylindrical rails, rimmed wheels, and small shafts, rolling friction is kept to a minimum and perfect alignment is maintained.

Positioning of the carriages at the initial spacing of 1 in. in the center of the specimen is accomplished with the two blocks clamped to the rear support rod and corresponding microswitches on the upper and lower carriages. The lower block is adjustable so that the 1-in. spacing may be established accurately.

The carriages carry fingers which project horizontally forward to contact the specimen at what would normally be the position of benchmarks. The outer tip of the contact finger is supported on a long leaf spring so as to have a degree of freedom when the tip is moved downward. Breaking of electrical contact between it and an insulated stationary contact in its support initiates movement of the carriage drive motor to move the carriage downward and close the contact. The contact finger and its support member slide freely in a square tube and are pushed gently against the specimen by a light helical spring. The contact finger is placed on or retracted from the specimen by forward or backward motion of the small bakelite knobs seen at the rear of the carriages. Because the pressure of the fingers on the specimen is exceedingly light and the force necessary to open the contacts very small, practically continuous motion of the carriage is effected without slippage of the finger on the specimen. The complete contact assembly is hinged at the carriage and held horizontally by a flat leaf spring at its base. This construction permits the assembly to collapse against the carriage in a manner similar to a folding jack-knife blade when struck a heavy blow by a breaking specimen, thus preventing damage to the contact elements.

A clear plastic scale, engraved in inches and tenths, permits visual monitoring of performance and measurement of maximum extension at failure. The scale is fastened to the upper carriage and extension is followed with an index pointer on the lower carriage.

Motor Drive Unit:

An interior view of the motor drive unit is shown in Fig. 4. The motors and associated miniature thyratron control circuits are housed in the small duraluminum box affixed to the main column and turn with it as the assembly is swung from the measuring to the loading position. Barcol motors, type oYaz-430, are outfitted with outboard bearings to support worm gears for speed reduction to provide carriage speed of approximately 24 in. per min.

Three turns of the drive cables around the grooved drum provide sufficient grip to prevent slippage, and the grooves guide the cable and prevent climbing or overrunning. The grooved drums are insulated from each other and from their respective drive shafts by bakelite bushings, and electrical connection for the control circuits is made by brushes.

To effect the spark marking of the recorder chart for each 1-in. elongation

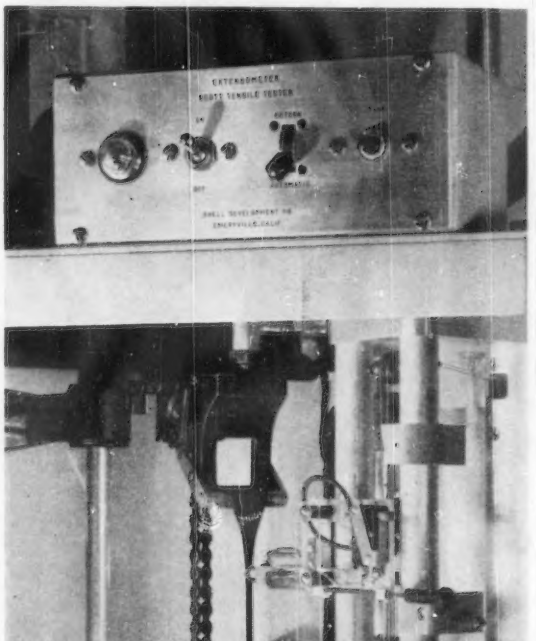

Fig. 3.—Extensometer for Scott Tensile Tester Follow-up Carriages in Operating Position.

[5] 3 by 3 by 0.005 in. preformed steel trolling cord.

of the initial 1-in. interval between probes, the drum diameter was selected so that each turn of cable was exactly 3 in., and a three-point commutator was placed on the upper carriage drum and a pickup brush on the lower carriage drum. Thus, each time the distance between the carriages increases by 1 in., commutator contact is made and the stress recorded.

Control Unit:

A small control box is provided on top of the cabinet, Fig. 3. On the panel are mounted the power switch and pilot light, toggle switch for "Automatic" and "Return" operation of the carriages, and a push botton for manually actuating the recording spark at the breaking point. In addition to these parts, the box contains the small transformer, selenium rectifier, capacitor, resistors, and relay, making up a fixed time circuit used to produce a spark of approximately $\frac{1}{10}$ sec duration which is independent of the dwell time of the commutator contacts in the drive drums.

Electronic Circuit:

Figure 5 is a wiring diagram of the complete extensometer consisting of the control unit and motor drive unit, which are interconnected by a multiconductor cable.

The motors, which are of the multiturn shaded pole type with a coil on each pole to effect reversal, are operated with both poles normally energized to take advantage of the dynamic braking thus afforded. The "down" direction coils are shorted through a pair of contacts on the "Return-Automatic" switch while the other coils, through impedance-matching transformers, are shorted in effect by the 2 D21 miniature thyratron anode currents. The thyratrons are fired by connecting the grid to the cathode through contacts on the probe finger. This circuit makes use of the drive cable to carry the connection from the tube grid through a return path of contacts, carriage, and tracks to the cathode. The indexing limit switches are wired in series with this circuit and stop the carriages at the starting position when they are traveling in the upward direction. When a probe finger contact is opened by downward movement of the specimen, the d-c bias supplied by the selenium rectifier stops the thyratron from firing, opening one drive coil which causes the remaining coil to drive the motor in a direction to move the carriage downward.

The spark commutator on the drive drums energizes the timing relay in the control unit. A contact on the "Return-Automatic" switch disconnects the relay voltage supply in the "Return" position so that the record is not sparked as the carriages return to the starting point.

A spark of suitable duration is produced by discharging a 2-μf capacitor in series with 3000 ohms through the relay. The condenser is charged through a 10,000-ohm resistor which, in combination with the 3000-ohm resistor, will not hold the relay closed; thus closure is momentary and independent of the length of time the actuating circuit is closed.

Extension of Principle to Curve Drawing:

With "X-Y" recorders now available, conversion of the described apparatus to continuous curve drawing would be relatively easy. The pendulum weighing mechanism would be replaced with a tension ring, tension or cantilever bar and strain gages (or differential transformer) applied to give an output proportional to load which would be connected to one axis of the millivolt recorder. A voltage proportional to the spacing between the probes would be obtained by coupling a multi-turn potentiometer to each drive drum, supplying them in parallel with a small d-c voltage, and applying the differential voltage between the sliders directly to the other axis of the recorder.

Circuit Operation:

At the completion of a test run, the carriages are at the bottom of their travel. The operator records the rupture stress manually by pressing the spark button on the control panel. The contact fingers are retracted, the extensometer rotated to the stand-by position and the "Return-Automatic" switch placed on "Return" to return the carriages to the starting position. This switch de-energizes the spark relay as mentioned above, and opens the direct connection across the motor running coil. The thyratron then causes motors to drive the carriages upward until the carriage-mounted limit switches are opened by the positioning blocks. The

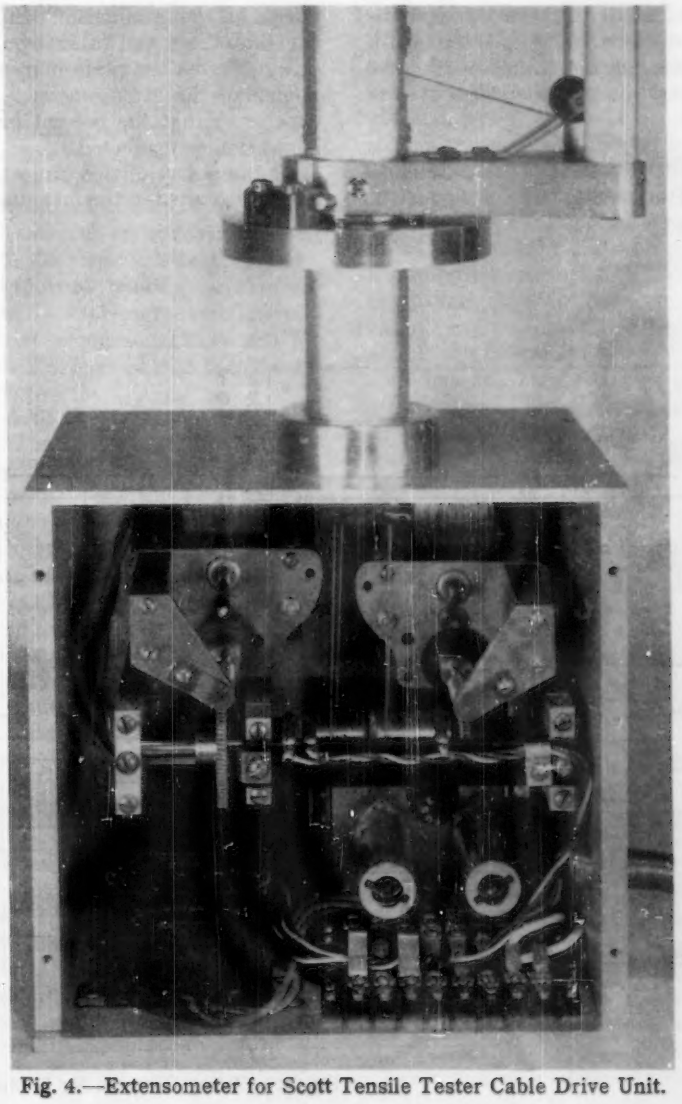

Fig. 4.—Extensometer for Scott Tensile Tester Cable Drive Unit.

carriages generally return in about 15 sec or so, depending upon the ultimate elongation. The operator can just about return the head to zero and install a new specimen in this time.

After a new specimen is mounted, the extensometer is rotated to the operating position and the contact fingers are applied to the specimen by moving the manually operated retractors forward slowly to the limit of their travel. Upon placing the "Return-Automatic" switch in the "Automatic" position, the carriages move very slightly downward until the limit switches close. Because the contact fingers cannot move upward, they slide very slightly on the specimen, completely eliminating backlash from the entire follow-up system. The 1-in. spacing is, of course, made in this position. After starting the test, each incremental movement of the specimen sufficient to open the finger contacts is followed by a corresponding movement of the carriage which closes the contacts. The motion thus produced is virtually continuous since individual steps are only a few thousandths of an inch long.

Each time the distance between the probes increases by 1 in., the spark commutator on the drums sparks the record chart to show the stress at that extension.

Discussion:

The extensometer was designed to follow delicately and yet accurately the extension of a 1-in. portion of the reduced section of the specimen tested according to the ASTM Method D 412–49T. The evaluation of the extensometer was primarily concerned with how well the instrument would perform these functions, not only in the case of rather conventional rubber vulcanizates but also in the case of rubber compounds which possessed physical characteristics which would make the test more difficult. For example, exceptionally soft compounds such as undercured stocks might present problems at the start of the test when the rubber was under no tension in the event that the probe pressure deformed the specimen so that the original positioning of the bench marks was in error. Compounds from which plasticizer was exuding might present an oily surface on which the probes might not track properly. The highly smooth, hard surface of molded polyvinyl chloride might present similar troubles. The repeated violent jarring at fracture of a high-quality tire tread stock might be expected to have adverse effects on the mechanism. Suffice it to say that these and other troubles seriously affected the performance of early models of the extensometer. It is our experience that the present instrument is not similarly affected.

At the outset of this project, our objective as stated in the introduction was to develop a practical servo-mechanism which would measure the deformations obtained in the standard tension test for rubber with improved accuracy and less work. To test the reliability of the instrument, tension test data obtained through its use were compared with corresponding data obtained from tension tests in which the extensions were obtained by observing through a transparent plastic scale the separation of crayon bench marks upon the specimen. This amounted to a statistical analysis of a fairly large volume of data derived from a planned experiment. The plan included a variety of materials which might give rise to the difficulties outlined above as well as more usual rubber stocks. These experiments in effect compared the performance of the extensometer under most adverse conditions with that of the visual test under conditions most favorable to it. Under these more difficult conditions, as well as under ordinary circumstances, the extensometer gave data just as reliable as those obtained with the visual technique.

This comparison, however, included the optimum performance of the visual test. We feel certain that this optimum is not obtained in general routine testing, particularly where several operators are normally used to perform the test at widely different times. The extensometer, when properly cared for,

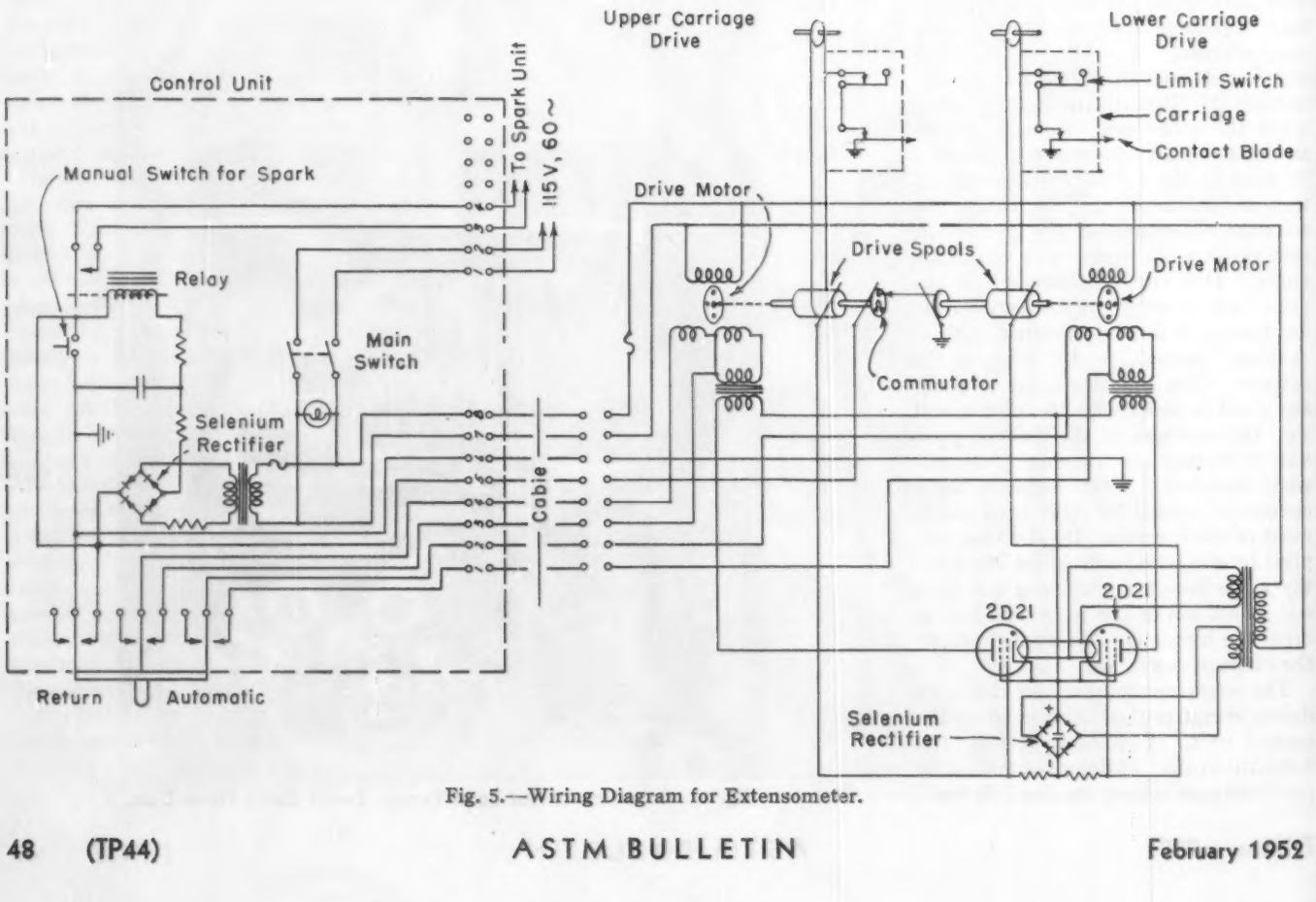

Fig. 5.—Wiring Diagram for Extensometer.

always operates at or near its optimum. Since the extensometer requires only a moderate amount of care, the reduction in drudgery is apparent as is the expectation of higher over-all accuracy. The precision of the measurement in large measure depends upon the quality of the specimen, and so it is difficult to generalize in this regard. To cite the general order of the precision obtained with the extensometer we might refer to a test on a tire tread stock from which 14 replicate specimens were tested. Its tensile strength of 3080 psi was determined with a standard deviation of 84 psi; the 300 per cent modulus of 1211 psi with a standard deviation of 63 psi, and its elongation of 588 per cent with a standard deviation of 22 per cent.

The extensometer has been successfully used at temperatures as high as 100 C. It is our opinion after continued use of this extensometer that this development has significantly improved the tension testing of elastomers in our laboratories.

Acknowledgment:

The authors wish to extend their thanks to a number of their colleagues on the Shell Development staff who assisted in this work.

Abradoflex—Abrasion Resistance Tester

By M. C. Shaw[1]

SYNOPSIS

A wearability testing machine has been developed for asbestos textiles and other fabrics, particularly of the heavier grades. The destructive actions of abrasion, flexing, and creasing are simultaneously applied to cloths under test and the resulting degradation evaluated in terms of loss in tensile strength. The Abradoflex rating index derived from these determinations serves to indicate the relative wearability of the textiles so tested.

THE service to which many asbestos textiles are subjected is often such that the wearability of the cloth may be the major factor upon which its usefulness is based. The relative wearability of a textile reflects the extent to which such cloths may resist loss in strength and structure as a result of: (1) abrasion induced by foreign materials constantly or intermittently acting upon the surface of the cloth, (2) the wear resulting from two faces of the same or similar cloths rubbing against each other, and (3) a flexing action wherein the cloth may be periodically subjected to a creasing or folding action.

In asbestos safety clothing, draperies, and similar applications, all of the above factors are influential and frequently the most significant in the ultimate destruction of such textiles.

The problem of properly evaluating the abrasive resistance qualities of textiles has received considerable attention in recent years, and several interesting devices for determining abrasion resistance factors have been developed. The most widely used test procedures for such evaluations utilize methods wherein the materials under investigation are securely mounted in a horizontal position and an abradant is constantly applied in rotary motion for specific time periods. The amount of destruction is determined as a function of the reduction in weight or thickness, and the resultant values serve to indicate the relative abrasion resistance qualities of the cloths. The results of such tests, particularly as applied to the heavy asbestos cloths, have not proved entirely satisfactory due to the lack of reproducibility and the difficulty encountered in correlating the results so obtained with actual service records.

In light of these considerations the Asbestos Textile Inst initiated an investigation that would direct a solution to the abrasion problems peculiarly inherent in the service applications of asbestos textiles. The industry has for some time been aware of the fact that certain cloths with unique weave and construction characteristics possess the ability markedly to resist the physical destruction with which we are concerned. Certain treatments during and after weaving have also been found to influence directly abrasion resistance qualities.

The problem presented was to develop a testing machine wherein the relative abrasion resistance qualities of the many varieties of asbestos textiles might be determined so that the manufacturers could provide the most suitable textiles for applications where abrasion resistance is of paramount importance. The test should, if possible, simulate the service conditions encountered by asbestos cloths when used in clothing, draperies, etc. In such cases, the cloths are not rigidly held in one position and repeatedly abraded in that position, but rather, are to some extent loose and have a degree of freedom of movement. In addition, the abrading action is usually quite discontinuous, and this discontinuity in conjunction with some movement permits the removal of the dust and lint products resulting from the abrasive action on the body of the fabric. The removal of these products is important for, if they are permitted to remain, they may serve as an added abrading material or they may act as a pad and retard the destructive action of the abrading medium. Either of these conditions, if uncontrolled, might vitiate results and be responsible for an extensive lack of correlation.

It has not been our purpose to disparage any of the abrasion testing machines presently available and in use but rather to devise a test method and technique whereby heavy-weight textiles such as those produced by the asbestos textile industry might be evaluated.

ABRADOFLEX TESTER

Machine Description:

After extensive preliminary investigation and experimentation the ATI (Asbestos Textile Inst) Abradoflex was finally designed to include those features deemed necessary to subject textile samples to a reasonably simulative service abrasion and flexural destruction test (Fig. 1). The essential parts of the machine are two cylinders, an upper cylinder which serves to hold the specimens during the test and a lower cylinder consisting of a series of four rolls upon three of which are mounted the abrasive materials. The upper cylinder is 6 in. in diameter and is provided with 24 spool clamps by means of which each of twelve specimens for

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

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Fig. 1.—Abradoflex Tester.

test may be permanently attached in the form of a loop, as illustrated in Fig. 1. The lower cylinders, four in number, are of steel and are 2 in. in diameter by $3\frac{1}{4}$ in. long. On the surface of three of these rolls a facing of No. 1 grade carborundum cloth is applied. A new abrasive facing is applied at the beginning of each test. The fourth roll presents a bare steel face for the flexing test evaluations. The distance between the large cylinder and the small cylinders is such that, at the closest points, they are separated by a dimension equal to three times the thickness of the cloth being tested. In operation, both cylinders revolve in the same direction with the upper cylinder rotating at 100 rpm and the smaller cylinders at 50 rpm.

Test Procedure:

For a specific test, 15 representative samples of a given cloth are cut to the dimensions of 2 by 13 in. and raveled to $1\frac{3}{4}$ by $12\frac{1}{2}$ in. Twelve of the specimens are clamped onto the machine. Nine specimens are placed so that they will contact the abrasive covered rolls, and three specimens are set to work over the bare steel roll. The remaining three specimens are reserved and represent the unabraded cloths which serve as the basis for final evaluation.

The action of the machine during the test is such that the cloth first slaps against the abrading surface, is then dragged over this surface and, upon emerging from the abrading action, flexes out into a loop form preparatory to a repetition of the same treatment. This operation continues at the rate of 100 cpm for the duration of the test.

Figure 2 presents a schematic illustration of the various positions assumed by the test specimen during the course of one revolution of this test. Position *A* shows cloth specimens 1, 2, and 3 in full swing. In position *B*, some 30 deg later, specimens 2 and 3 are in fully flexed positions while specimen 1 is making positive contact with the abrasive medium and is being wrapped around this spool. Little or no abrasion is effected at this point. Position *C* illustrates a further advancement with specimen 1 tightly wrapped around the abrasive spool and being abraded through the action of the abrading spool turning in the opposite direction to the path of travel of the specimen. Position *D* shows a further advancement and specimen 1 is subjected to the final abrasive action prior to emergence with subsequent flexing and opening preparatory to the continued repetition of the actions.

Two photographs shown in Fig. 3 illustrate positions assumed by test cloths during actual test. In Fig. 3(*a*), the upper set of four specimens is in full swing, fully looped and is approximately 90 deg from the abrasion cylinder while the lower set of cloths is in position to make initial contact with the abrasion cylinder. In Fig. 3(*b*) there are also two sets of cloths in progressively advancing positions, the upper set having just emerged from contact with the abrasion cylinder while the

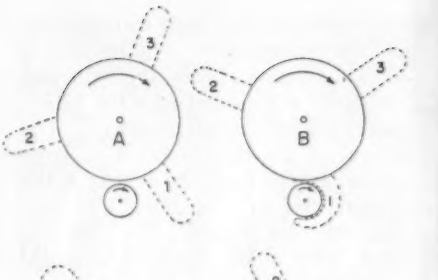


Fig. 2.—Schematic Drawing Showing Advancing Positions of Test Specimens During Abradoflex Test.

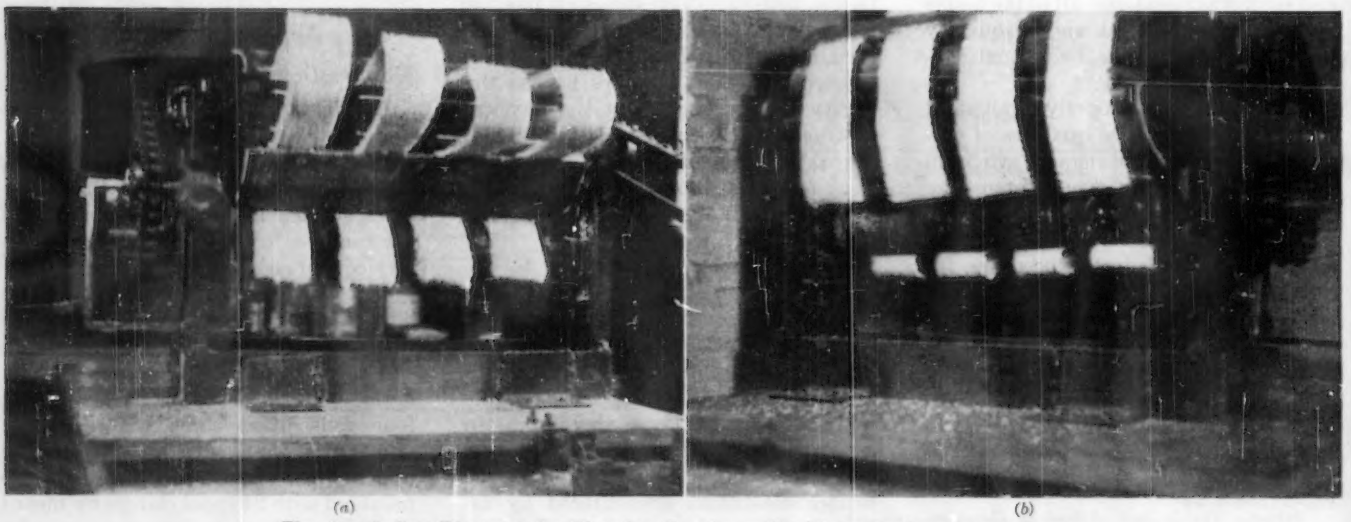
lower set which is in evidence only partially, below the abrasion cylinder, is nearly fully wrapped onto and are about to be dragged over the abrasion cylinder.

The sketches and photographs serve to illustrate the extent to which action is induced in the specimens during the course of an abradoflex test.

Three of the specimens working against the abrasive cloth are run for $\frac{1}{2}$ hr and are then removed for measurement. Three additional specimens are run for 1 hr and are then removed, and the three remaining abrasion test specimens are run to the point of destruction or until a total elapsed time of 180 min has been consumed. The three specimens which are mounted to work over the bare steel roll, wherein little or no abrasion is evidenced, are run for the full 180 min and serve to indicate the flexural strength of the cloths so treated.

Evaluation of Test Results:

Upon completion of the test, the several specimens are prepared for tensile



(*a*) (*b*)

Fig. 3.—Action Photographs Showing Specimen Positions During Actual Test.

strength testing. All specimens are subjected to a modified raveled strip method tension test wherein each specimen is in full width, $1\frac{3}{4}$ in., and 2-in. jaws are used on the front and back anvils of the tension test machine. A 6-in. section of the abraded section of each specimen is cut from the full length to serve as a tension test strip. In the case of the flexural strength specimens, the tension test samples are cut so that the point of creasing is in the exact center of the 6-in. test strip.

The reduction in tensile strength values as a result of abrasion at the three different time intervals serves to indicate the rate at which abrasive destruction is promoted and the time required to obtain 100 per cent destruction or the extent of strength deterioration after 180 min serves to indicate the relative abrasion resistance qualities of the cloths so tested. The finite evaluation of a given test is incorporated in the "Abradoflex Rating."

Abradoflex Rating:

The abradoflex rating or rate of attrition factor reveals at a glance the relative abrasion resistance qualities of the cloths on the basis of this test. It is an arbitrary index consisting of four digits. The first two digits indicate the final state of degradation in terms of percentage strength retention after the completion of the test. The third digit multiplied by 10 gives the percentage of the tensile strength retained after the 1-hr test period. The fourth and last figure multiplied by 10 shows the percentage of retained strength after the 30-min test period. For example, a cloth may have an index value of 5478, which shows that the cloth withstood the test for 180 min and retained 54 per cent of its original strength after that period. The third digit, 7, indicates that 70 per cent of the original strength was retained after the 1-hr test, and the last digit, 8, indicates that 80 per cent of the original strength was retained after the 30-min test. A second cloth, on the other hand, may have failed to withstand the 180-min test and is therefore given a fractional index with a decimal point preceding the first figure. The interpretation of these fractional values is somewhat different than for the whole number indices. For example, this latter cloth which might have the index 0.6235, where the decimal indicates that destruction was accomplished before the 180-min test period could be completed. The first two digits, 62, indicates that the time necessary to destroy the cloth was 62 per cent of the test period of 180 min. The final two digits indicate the strength retention characteristics for the 60- and 30-min test periods and bear the same interpretation as in the first example cited.

In general, directly proportional relationships may be made and a cloth having an index 2058 may be considered to be twice as resistant to abrasion, on the basis of this test, as a cloth having an index of 1026. In the case of the fractional numbers, the decimal indicates that cloths so designated withstood the test for only a fractional part of the entire test period, and the greater the value of the first two digits of these indices, the longer the period of test. Therefore, the size of the number, irrespective of the decimal point, indicates the relative abrasion resistance of the cloth so indexed.

Flexural Rating:

The rating for flexural strength values is in terms of per cent loss in strength after the duration of the 180-min test. For example, specimen A may have a 7 per cent loss in strength as a result of the flexing test while specimen B may show a 9.1 per cent loss in strength after submission to the test for the scheduled 180 min. Therefore, the higher the values of the rating indicate more destruction as a result of the flexing action.

Summary of Results

In the course of the work during which the abradoflex was developed and investigated, a great number of tests on all grades and many constructions of asbestos textiles were made. The purpose of the experimental work during this time has not been primarily to evaluate the abrasive resistant qualities of the individual cloths so tested but rather to establish the operational characteristics of the abradoflex tester. Many more tests covering a far greater variety of cloths will be required before abrasion resistance and flexural destruction resistance characteristics of a particular class of materials can be established. The test results do, however, indicate the efficacy of the test method and procedure here presented and the values given in Table I serve to illustrate the range of values attainable by this procedure. General information is included covering the construction characteristics and unique features of the textiles.

As stated previously, no attempt should be made to analyze the tabulated data in an effort to evaluate the characteristics of any of the cloths here presented since the data are not necessarily representative of the industry-wide commercial products available. The tabulation does, however, indicate the range of values that may be obtained over a series of asbestos cloths having a wide variety of weights and constructions.

The first 14 cloths withstood the test for the entire cycle and have, therefore, whole numbers for indices. The last 17 cloths, on the other hand, failed prior to the completion of the established cycle and have fractional indices. The effects of the so-called weaving conditions are reflected in the Abradoflex and Flexural Ratings.

The weights of the cloths included in this work range from 1.00 to 3.81 lb per sq yd. The effect of weight, construc-

TABLE I.—ABRADOFLEX AND FLEXURAL RATINGS FOR A SERIES OF ASBESTOS TEXTILES.

Specimen Number Weave	Weaving Condition	Grade	Weight, lb per sq yd	Construction, yarn count	Abradoflex Rating	Flexural Rating
21 P	ST	Und.	2.43	20 × 11	5478	7.0
73 T	W	AA	1.94	27 × 17	5078	0.0
75 P	W	AAA	3.00	18 × 9	2456	7.05
11 H	ST	Und.	2.38	28 × 13	2456	20.0
70 P	D	Und.	2.44	20 × 9	1835	6.3
71 T	D	AA	2.09	27 × 18	1235	0.0
62 P	D	AAA	2.60	20 × 11	1235	3.4
89 H	D	Und.	2.36	28 × 14	1146	9.9
61 P	D	Und.	2.60	20 × 10	1036	3.9
64 H	D	Comm.	2.54	28 × 13	1035	10.1
13 H	D	Und.	2.35	27 × 12	1024	14.0
20 T	D	AAAA	3.81	36 × 12	1014	55.0
72 T	D	AA	1.95	27 × 17	0766	5.3
69 P	D	Und.	2.31	18 × 9	0134	3.2
39 P	D	AA	2.20	19 × 9	0.9024	11.0
44 P	D	Und.	2.30	19 × 9	0.7412	8.9
33 H	D	Und.	2.42	31 × 14	0.6235	9.1
58 P	D	AA	2.63	20 × 10	0.5923	9.3
68 P	D	Und.	2.12	18 × 7	0.4623	6.9
77 P	D	AA	2.34	18 × 9	0.4102	7.5
80 P	D	Und.	2.40	18 × 8	0.3401	5.6
47 P	D	AAA	1.52	17 × 15	0.3201	6.0
84 P	D	Und.	1.69	20 × 13	0.2602	4.5
30 P	D	AA	1.39	15 × 13	0.1805	4.0
74 P	D	AAA	1.425	19 × 11	0.2000	8.4
67 P	D	Und.	1.54	14 × 12	0.1700	4.9
76 P	D	AA	1.31	14 × 12	0.1400	6.9
14 P	D	AA	2.07	20 × 10	0.1400	2.9
52 T	D	Und.	2.07	19 × 17	0.1300	1.3
46 P	D	AA	1.47	17 × 16	0.1300	7.5
88 P	D	Und.	1.00	17 × 15	0.0700	1.0

Note: P—Plain Weave; T—Twill Weave; H—Herringbone; D—Dry Woven; W—Wet Woven; ST—Special Treatment.

tion, and yarn characteristics, while not apparent from this tabulation, seem to bear correlation with abrasion resistance characteristics. Further work will reveal the extent to which such correlations may be carried out.

Conclusion

The Abradoflex tester presents a new approach to the problem of evaluating the abrasion-resistant characteristics of textiles. The technique was devised primarily for the determination of the properties as they pertain to asbestos textiles; however, it would seem quite logical to assume that a similar procedure could be adopted in the investigation of other textile materials which may be subjected to similar service requirements. The Abradoflex serves to test the cloths while they are "at work." In many cases of actual service, the cloths are in some sort of motion or movement at the time that abrasion is being affected and it has been the purpose of this investigation to simulate, as closely as is practicable, these motions at the same time that the abrasion actions are being promoted.

The method of test and the techniques involved are extremely simple and the evaluations are based upon the tensile strength characteristics of the textiles after the predetermined testing schedule has been completed. Such evaluations are boldly positive and offer a substantial basis upon which the abrasion resistance characteristics of one textile material may be compared with those of another.

Calendar of Other Society Events

National Association of Corrosion Engineers—March 10–14, Annual Conference and Exhibition, Buccaneer and Galvez Hotels, Galveston, Tex.

American Railway Engineering Association—March 11–13, Annual Meeting, Palmer House, Chicago, Ill.

The Society of the Plastics Industry Inc.—March 11–14, Fifth National Plastics Exposition, Convention Hall, Philadelphia, Pa.

Technical Societies Council of New York, Inc.—March 13, Engineering Societies Building, New York, N. Y.

American Institute of Chemical Engineers—March 16–19, Regional Meeting Atlanta Biltmore Hotel, Atlanta, Ga.

American Society of Tool Engineers—March 17–22, Tool Engineers' Industrial Exposition, Chicago International Amphitheatre, Chicago, Ill.

Chicago International Trade Fair—March 22–April 6, Navy Pier, Chicago, Ill.

American Chemical Society—March 23–27, 121st National Meeting, Buffalo, N. Y.

American Society of Mechanical Engineers—March 24–26, Spring Meeting, University of Washington, Seattle, Wash.

American Power Conference—March 26–28, 1st Annual Conference, Sherman Hotel, Chicago, Ill.

American Society for Quality Control—March 28–29, Annual Middle Atlantic Regional Convention, Hotel Statler, New York, N. Y.

American Chemical Society—March 30–April 3, 121st National Meeting (divided), Milwaukee, Wis.

American Management Association—April 1–4, 21st National Packaging Exposition, Auditorium, Atlantic City, N. J

American Society of Lubrication Engineers—April 7–9, Annual Meeting and Lubrication Show, Hotel Statler, Cleveland, Ohio.

Society of the Plastics Industry—April 9–11, Seventh Annual Technical Session, Reinforced Plastics Division, Edgewater Beach Hotel, Chicago, Ill.

American Institute of Electrical Engineers—April 15–17, Southwest District Meeting, Jefferson Hotel, St. Louis, Mo.

American Ceramic Society—April 27–May 1, 54th Annual Meeting, William Penn Hotel, Pittsburgh, Pa.

American Oil Chemists' Society—April 28–30, 1952 Spring Meeting, Shamrock Hotel, Houston, Tex.

American Foundrymen's Society—May 1–7, 56th Annual Convention, International Foundry Congress and Show, Atlantic City, N. J.

Dallas-Houston Production Clubs—May 2–3, Joint Annual Meeting, Stoneleigh Hotel, Dallas, Tex.

Society for Experimental Stress Analysis—May 14–17, Hotel Lincoln, Indianapolis, Ind.

Society of Automotive Engineers—June 1–6 (Summer Meeting), Ambassador and Ritz-Carlton Hotels, Atlantic City, N. J.

American Society of Mechanical Engineers—June 15–19, Semi-Annual Meeting, Sheraton Gibson, Cincinnati, Ohio.

American Society of Civil Engineers—June 16–20, Denver, Colo.

American Society for Testing Materials—June 23–27, Fiftieth Anniversary Meeting, Hotels Statler and New Yorker, New York, N. Y.

American Institute of Electrical Engineers—June 23–27, Summer General Meeting, Hotel Nicollet, Minneapolis, Minn.

American Society for Engineering Education—June 23–27, Annual Meeting, Dartmouth College, Hanover, N. H.

American Society of Mechanical Engineers—June 23–27, Oil and Gas Power Div. Conf., Hotel Statler, Buffalo, N. Y.

Society of Automotive Engineers—August 11–13, National West Coast Meeting, Fairmont Hotel, San Francisco, Calif.

American Institute of Electrical Engineers—August 19–22, Pacific General Meeting, Phoenix, Ariz.

Centennial of Engineering Celebration—Sept. 3–13, Chicago, Ill.

American Society of Mechanical Engineers—Sept. 8–11, Fall Meeting, Hotel Sheraton, Chicago, Ill.

Society of Naval Architects and Marine Engineers—November 12–15, 60th Annual Meeting, Waldorf Astoria Hotel, New York, N. Y.

American Society of Mechanical Engineers—November 30–December 5, Annual Meeting, Hotel Statler, New York, N. Y.

American Institute of Chemical Engineers—December 7–10, Annual Meeting, Cleveland and Carter Hotels, Cleveland, Ohio.

Instrument Fish

Machines may have ousted the horse and buggy, but sanitary engineers point out that there is not yet any technological unemployment among blunt-nosed minnows. They are still better than any known chemical method at detecting the presence of phenol in water.

Trace quantities of phenol—as low as one part in a billion—can give water an offensive odor and taste. This is intensified if the water is chlorinated. No instrument has been developed for detecting the phenol at such low concentrations.

Minnows, though, can be trained to give the warning. Over a period of time, a little phenol is introduced in their aquarium as they are fed. This sets up a conditioned reflex; they react to phenol as to a dinner bell. When water to be tested is poured into their tank, they will, if phenol is present, swarm to the corner where they are accustomed to be fed.

Plastics Symposium at NBS

The mechanisms of polymer degradation were the subject of a recent symposium at the National Bureau of Standards, one of a series marking the fiftieth anniversary of the Bureau's establishment.

The meeting brought together about 200 scientists from this country and abroad who are engaged in the study of the manner in which plastics break down on exposure to light, heat, moisture, and other deteriorating influences. The six sessions covered specifically the fundamental theories of degradation; degradation of polyvinyl chloride-type polymers; oxidation of polyethylene and its stablization; and oxidation mechanisms of the cellulosic polymers.

To make the results reported at this symposium generally available the National Bureau of Standards plans to publish the proceedings together with discussion and submitted comments.

(*Continued from p. 28*)

The unit, called the "Carbotrane," is a complete, self-contained piece of laboratory apparatus. It is a compact arrangement of throwaway and replaceable glass cartridges containing reagents commonly used in the determination of carbon in metals. Two models are available. A single train (Burrell Model 110) is offered for average laboratory use, while a double train (Burrell Carbotrane Model 120) is intended to high production or for standby convenience. With the double train model, two determinations may be made simultaneously with complete efficiency. Four absorption tubes comprise the train. Bulletin No. 323 published by Burrell describes the unit.

Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.

pH Electrometer—The Coleman Model 20 "Compax" is a self-contained, portable pH electrometer said to combine the precision of the linear potentiometer with the complete simplicity of single dial operation. New features include a "flashing signal" which eliminates meters, pointers, and "reset" knobs and establishes the reading point with pinpoint precision; batteries with a useful life of more than 1200 operating hours; complete protection against measurement errors due to depleted batteries, amplifier drift, or accidental misadjustment of controls; an electrode system which is automatically brought to operating position when the instrument cover is opened and returned to storage within the case when the cover is closed. All operations of standardization and measurement are accomplished with a single calibrated dial. There are no other knobs or controls required. The entire instrument is enclosed in a stainproof plastic case, 8½ by 6¾ by 4⅛ in. Weight 5½ lb. Bulletin B-225 available from the manufacturer describes the instrument.

Coleman Instruments, Inc., 318 Madison St., Maywood, Ill.

Melting Point Apparatus—According to its American distributor the "Kofler Hot Bench" manufactured by the Optische Werke C. Reichert of Vienna makes possible the determination of the melting point of organic substances in a few seconds. The equipment has a range of 50 deg to 260 deg C. with an accuracy of 1 deg C. The distributor states applications of the instrument as; determining eutectic temperatures; ascertaining the presence and behavior of crystalline water; observing decomposition, and sublimation; judging volatility; and checking purity.

William J. Hacker & Co., Inc., 82 Beaver St., New York 5, N. Y.

Universal pH Meter—A new universal pH meter, built for reliable service and for quick, accurate measurements of hydrogen-ion concentrations, is now available. The new instrument is designed for all pH and rH work, for potentiometric titrations and for oxidation-reduction-potential investigations. For laboratory research and industrial testing purposes it is said to provide a measuring accuracy of 0.01 pH or 0.5 mv, a range of 0–14.15 pH and 0–1415 mv, absolutely currentless measuring with no phenomena of polarization, zero indication by cathode ray tube. It can be used with glass, quinhydrone, hydrogen and platina electrodes and is direct calibrated for the first three. The pH meter is enclosed in a wood cabinet measuring 16¾ in. long, 13¾ in. wide, and 10 in. high and weighing 46 lb.

Research & Control Instruments Div., North American Phillips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.

Low Magnification Strain Instruments—A completely new line of "C-Type" low magnification strain instruments is now being offered. The C-1 instrument has 3 magnifications, of 10, 20, and 40; the C-2 provides magnifications of 1, 2, and 4; the C-3 provides magnifications of 2½, 5, and 10. When used in conjunction with the S-Type extensometer, complete stress-strain curves may be produced automatically without stopping tests. Used to detect large motions of specimen deformation in tension, compression, and flexure testing, C-Type instruments transmit signals by means of special differential transformers which rotate the recorder drum in direct proportion to the motion measured (usually crosshead differential travel). These instruments may also be used as deflectometers. Weighing only 2½ lb (4 by 4 by 4½ in.) the instrument may be placed either on the table, crosshead or platform of the testing machine. C-Type instruments are guaranteed to return to zero, since backlash eliminators are built-in. Calibration is based on fixed linear distances of the lever.

Tinius Olsen Testing Machine Co., 1152 Easton Road, Willow Grove, Pa.

Cloud and Pour Test Bath—A redesigned bath called the "Frigistat" is said to provide frost-free, efficient operation with a minimum of temperature control adjustments. Designed expressly for following ASTM Method D 97, the bath, although manually operated, can easily be maintained within ±2 F. The seven unit test chamber and the dry ice chamber are insulated with 2½ in. of glass wool at the sides and bottom. Cooling medium is circulated in the test chamber through coils which do not allow interchange of fluid between chambers. Dry ice capacity is ample. A full charge of dry ice plus the efficient ½-hp pump will reduce temperature of the test chamber to −90 F in about one-half hour. Made of steel, except for a heavy bakelite top, the housing is finished in silver-tone Hamerloid baked enamel. Inner chambers are pure spun copper; all pipes and fittings are of brass. Over-all dimensions: 24½ in. wide by 13 in. deep by 18 in. high. Immediately available.

Precision Scientific Co., 3737 W. Cortland St., Chicago 47, Ill.

Laboratory Centrifuge—A new, low-priced angle head centrifuge is being introduced by the Scientific Glass Apparatus Co. It is particularly recommended for those applications where fast individual tests are required. To protect the operator, and to prolong the life and usefulness of the unit, all rotating parts are concealed—including the vital parts of the machine itself. This is accomplished by means of an aluminum guard with a convenient opening at the top, fastened by screws to the base. Three large rubber suction feet are provided for additional safety and smooth operation. The outside diameter of the centrifuge is 9¾ in. at the base. The height is 8½ in.

The Scientific Glass Apparatus Co., Inc., Bloomfield, N. J.

Weighing System—Scott Testers, Inc. announce a new electrical weighing system for application to existing Scott Testers of the pendulum type. This new unit called the "Inertialess Weighing System" replaces the conventional pendulum type head and recorder, converting the tester from constant-speed-of-pull operation to constant-rate-of-extension. Resistance of the specimen, or load, is absorbed by the deflection of an elastic spool, which is converted to a voltage and measured by a potentiometer with recording chart. On the chart, extension of the specimen is shown vertically and load horizontally. Inasmuch as chart speed and clamp speed are both time functions, the chart becomes a stress-strain diagram directly, with either variable (load or extension) magnified or condensed as desired. The advantages stated for the unit are: *First*, inertia is practically eliminated from the weighing mechanism. The improved sensitivity reflects the behavior of the specimen in more minute detail, particularly when minute changes are magnified as described above. *Second*, it is possible to apply a constant rate of extension. The elastic spool of the weighing head elongates only 0.0015 in. maximum. *Third*, the flexibility of drive and recorder rates and wide range of chart speeds available, permits new studies of progressive test stages. Application of the new system to existing Scott Testers is said to be extremely simple.

Scott Testers, Inc., 1120 Blackstone St., Providence, R. I.

INSTRUMENT COMPANY NEWS . . . .

Announcements, changes in personnel, new plants and locations, and other notes of interest

Weston Electrical Instrument Corp., Newark, N. J. The promotion of Philip Barnes to director of the sales division of the Weston Electrical Instrument Corp., is announced by Earl R. Mellen, president of the company. Barnes, formerly general sales manager, has been with Weston for 16 years. Following his return from active duty in the U. S. Navy during World War II, he became advertising manager, then general sales manager.

Fish-Schurman Corp., New Rochelle, N. Y. Representative scientists and glass technologists honored the centenary of the birth of Otto Schott (1851–1935), pioneer glass technologist and founder of the world-famed Jena Glass Works Schott & Gen., at a meeting held in Witten (Ruhr) in West Germany on December 17, 1951. The celebration was sponsored by the "Deutsche Glastechnische Gesellschaft" and the City of Witten. Professor Dr. Hans Schimank, of Hamburg, delivered the principal address and called Dr. Otto Schott the "creator of modern scientific glass technology." Present was Dr. Erich Schott, son of Otto Schott and his successor as head of the firm. The Jena Glass Works is represented in the United States by Fish-Schurman Corp., New Rochelle, N. Y., who have supplied its products to American users for more than 25 years.

PROFESSIONAL CARDS

Commercial Testing and Research:

- Chemical
- Metallurgical
- Physical
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- Spectrographic
- Sampling

PATZIG TESTING LABORATORIES

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TESTS • ANALYSIS • RESEARCH
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MATERIALS & PRODUCTS

Ingersoll Ave. & 23rd St. Des Moines, Iowa

SMITH-EMERY COMPANY

Established 1910
Chemists — Engineers
Sampling, Analyzing, Assaying
Spectography, Physical Testing
Member: American Council of Commercial Laboratories
920 Santee St. Los Angeles 15, Calif.

SOUTHWESTERN LABORATORIES

Consulting, Analytical Chemists and Testing Engineers
Member A.C.C.L.
Inspections, Testing and Chemical Work
Fort Worth, Dallas, and Houston, Texas

Testing • Inspection • Consulting
Product Development & Research
United States Testing Company, Inc.
Hoboken, N. J.
PHILADELPHIA • BOSTON • PROVIDENCE • MEMPHIS • DENVER
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